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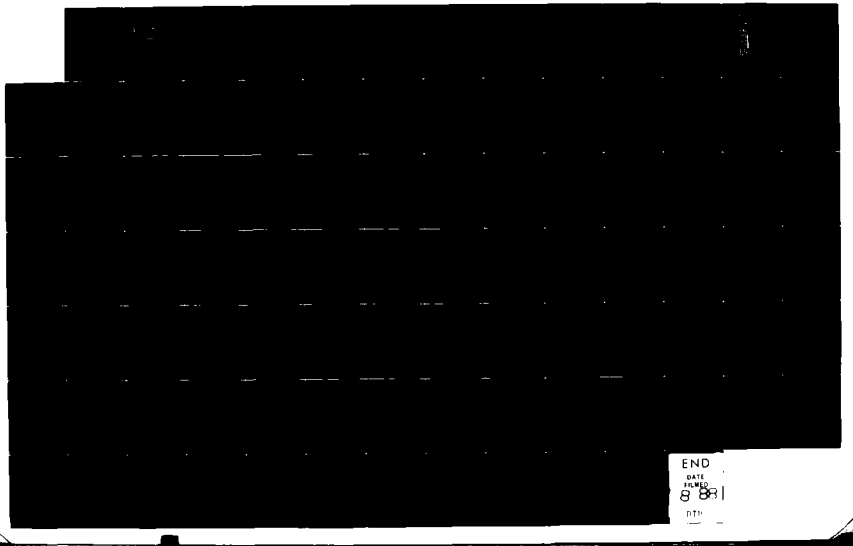

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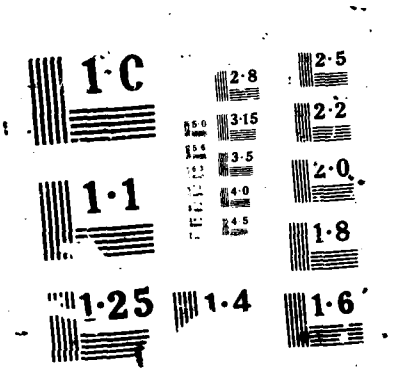
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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

Application of Speech Recognition
to the
Integrated Tactical Decision Aid (ITDA)

by

Jerry K. Hill

March 1988

Thesis Advisor: Gary K. Poock

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The author investigates the operation of the "Integrated Tactical Decision Aid", (ITDA), using a VOTAN 6050 series II, speaker dependent, continuous Speech Recognition Device, (SRD). The ITDA's unique features directly affect the application of an SRD. It is an interactive, menu driven program designed to be operated from the keyboard only. The SRD must be connected to the host computer, the HP 9020, through a remote user port. The ITDA is multi-leveled with several menu names being assigned to different levels. The SRD can not assign more than one meaning to the same word. These problems were mostly overcome and the ITDA was successfully operated by voice. The recommended vocabulary for the ITDA 'CONTACTS' module is presented. Speech Recognition applications to C3 systems is summarized as a very efficient method of man-machine interface. The current ITDA software does not permit an efficient application of speech. Software changes to the ITDA are recommended as well as further studies in this area.

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Application of Speech Recognition
to the
Intergrated Tactical Decision Aid (ITDA)

by

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Captain (P), United States Army
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Submitted in partial fulfillment of the
requirement for the degree of

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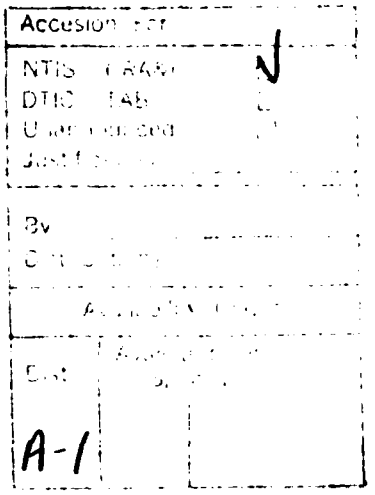
ABSTRACT

The author investigates the operation of the "Integrated Tactical Decision Aid", (ITDA), using a VOTAN 6050 series II, speaker dependent, continuous Speech Recognition Device, (SRD). The ITDA's unique features directly affect the application of an SRD. It is an interactive, menu driven program designed to be operated from the keyboard only. The SRD must be connected to the host computer, the HP 9020, through a remote user port. The ITDA is multi-leveled with several menu names being assigned to different levels. The SRD can not assign more than one meaning to the same word. These problems were mostly overcome and the ITDA was successfully operated by voice. The recommended vocabulary for the ITDA "CONTACTS" module is presented. Speech Recognition applications to C3 systems is summarized as a very efficient method of man-machine interface. The current ITDA software does not permit an efficient application of speech. Software changes to the ITDA are recommended as well as further studies in this area.



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I. SPEECH RECOGNITION AND THE OPERATION OF THE "INTEGRATED TACTICAL DECISION AID"

A. INTRODUCTION

The ever increasing complexity of modern combat has caused the development and use of computer assisted command and control decision aids.

> The major goal of command and control (C2) decision aids is to assist the decision maker by taking him beyond the burden of analyzing data with standard data manipulation and display techniques toward working with information relevant to his real world problem domain. [Ref 1]

The computer assisted C2 decision aid has added one more dimension to the complexity of the man-machine interface in command and control.

The man-machine interface and man's communication with the computer can be accomplished in a variety of ways. The most natural and efficient form of communication for man is that of speech. [Ref. 2] Speech activation, therefore should be considered as an appropriate interface in order to optimize the operation of the decision aid.

Research and subsequent technology in the area of automatic speech recognition has produced a variety of devices available today. A Speech Recognition Device (SRD) is one that translates recognized verbal commands into a predetermined output string which is then sent to the computer. There are many advantages of using speech to communicate with a computer. The most important of these, particularly in a command and control environment, is the ability to send multiple commands to the computer with a single voice command. It is not affected by low light levels, frees the operators hands and eyes to accomplish other tasks, and gives the operator freedom of movement, not confining him to a keyboard. [Ref. 3: p.3]

B. PURPOSE OF THE THESIS

The numerous research efforts in the area of speech recognition and its application have increased the awareness of the importance and value of the speech interface. The study and development of computer assisted C2 decision aids has enhanced the commander's ability to direct, coordinate and control forces in the battle arena. The purpose of this thesis is to bring these two technologies together, to further enhance the operation of the C2 decision aid, by accomplishing the speech interface and developing a usable vocabulary.

C. CONSTRAINTS

This research was accomplished with the following restrictions: The speech recognition system to be used was the VOTAN 6050 SERIES II. No changes could be made to the Integrated Tactical Decision Aid software.

D. SUMMARY

This thesis summarizes research in the area of speech recognition and that of the Integrated Tactical Decision Aid (ITDA). The hardware interface of the VOTAN continuous speech recognizer with the ITDA host computer, the HP 9020, is discussed as well as the software interface of the voice application to the ITDA characteristics. A possible vocabulary for one module of the ITDA and examples of successful speech operation of the ITDA are provided. The tools used in developing a vocabulary for the ITDA are provided in lieu of a complete vocabulary for the following reasons: For the voice interface to be completely successful, the ITDA program needs to be modified, which would also change the vocabulary. The author's conclusions from this effort and recommendations for further studies are also presented.

II. THE INTEGRATED TACTICAL DECISION AID (ITDA)

A. EVOLUTION OF THE ITDA

The Integrated Tactical Decision Aid was developed and is under constant revision by the Naval Air Development Center (NADC) as the Central Design Agency. The current version, Version 2.0, is now being fielded throughout the fleet. The ITDA is periodically updated and revised based on input from the field. This constant attention to and revision of the ITDA is making it a very useful and widely accepted addition to the Command, Control, and Communication (C3) system.

B. ITDA SYSTEM DESCRIPTION

The ITDA contains twelve modules which range from data management to decision support in the tactical environment. Appendix A contains a brief description for each module. Each of the modules fall into one of three categories, Stand Alone subsystems, Tactical Modeling, or General Support and Database. Each covered in a user's manual. [Ref. 4: p. 50]

The following are Tactical Modeling:

1. Antiair Warfare Module (AAW);
2. Antisubmarine Warfare Module (ASW);
3. Antisurface Warfare Module (ASUW), includes SASHEM;
4. Electronic Warfare Module (EW); and
5. Contacts Module.

The ITDA includes five Stand Alone subsystems:

1. Automated Strike Operations Decision Aid (ASODA);
2. Communication Planning Support (COPS);
3. Pattern Analysis Decision Aid (PANDA);
4. SAG or SAG Harpoon Engagement Module (SASHEM); and
5. Tomahawk Engagement Planning Exercise Evaluation (TEPEE).

The remaining two are General Support and Database modules:

1. Automatic Data Entry Module (ADE); and
2. Feature Build/Modify Ports.

C. HOST COMPUTER/HARDWARE

The Navy Standard Desktop Computer, the Hewlett Packard 9000 series 500 Model 20 microcomputer, HP 9020 is the host computer for the ITDA. The HP 9020 has a 32-bit central processing unit with 3.0 megabyte RAM, an interactive keyboard and Color-graphics display. It supports input from remote terminals through a Multiplexor Card (MUX Card) and a standard RS 232 cable.

The main keyboard of the HP 9020 has the standard alphanumeric keyboard (QWERTY style), a numeric keypad and several control keys. A row of sixteen special function keys (soft keys) provides a means for various programmable applications of up to thirty-two single key-stroke commands. [Ref. 4: p. 51] The ITDA makes good use of these special function keys which provides the user with greater flexibility in operation. Figure 2.1 is a display of the HP 9020 keyboard and ITDA special function key overlay. The Special Function Keys, (SFK), can be used any time "SFK" is displayed in the center of the menu row.

D. MAN-MACHINE INTERFACE AND THE ITDA

The Man-Machine Interface with the ITDA is primarily accomplished through a menu-driven interactive program. It is programmed to be operated from the HP 9020 main keyboard, providing only database access to remote users. [Ref. 5]

1. Menu Selection

The selection of menu items can be done by one of three methods:

a. By pressing the alphanumeric keyboard number which corresponds to the menu item number;

b. By pressing the numeric keypad number which corresponds to the menu item; or

c. By moving the highlighted menu item to the desired option by use of the space-bar and then pressing the Carriage Return <CR>. One space moves the highlighted item one position to the right. [Ref. 4: p. 53]

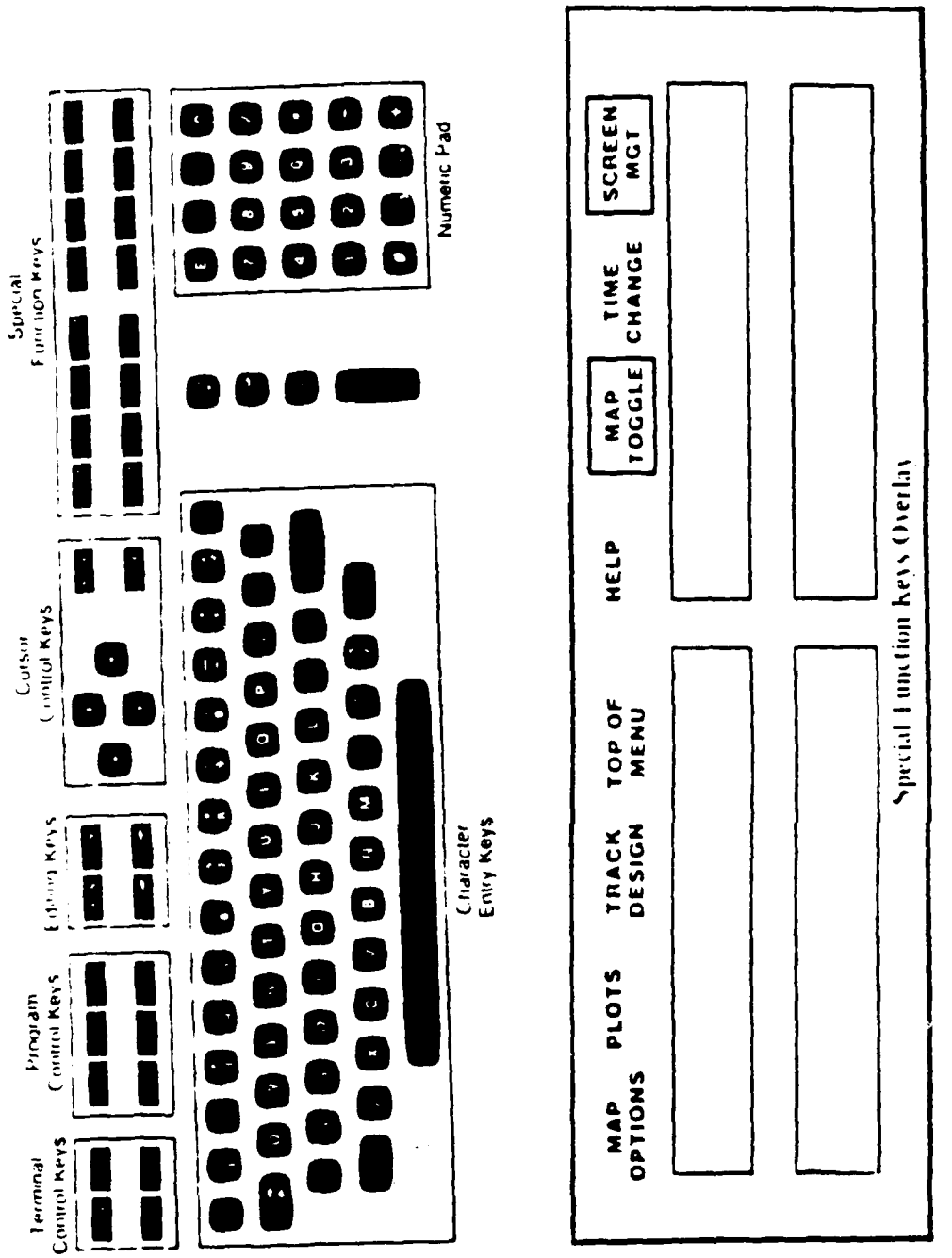

Figure 2.1 HP 9020 Key Board and Special Function Key Overlay

Note, methods a and b do not require the use of the <CR>. Once a menu item has been selected, the menu must completely refresh itself before another selection can be made.

2. Special Function Keys

The Special Function Keys (SFKs) provide the user with additional options and capabilities. The following is a listing of the SFKs and a brief description.

- SFK#0 Produce new geographic plots.
- SFK#1 Access plot aid routine.
- SFK#2 Design, edit, and delete formations and tracks.
- SFK#3 Return directly to the Main Menu from any other menu in the ITDA.
- SFK#4 Provide on-line Help.
- SFK#5 Toggle graphics and alphanumerics on and off.
- SFK#6 Change the system Time and Date.
- SFK#7 Store and Recall geoplot screens

3. Data Entry

At some point in the operation of the ITDA the user will be required to input data in the format of alphanumeric strings or cursor movement. The user will be prompted for the data entry by means of a short message on the screen. After the user's response the ITDA may request additional data or return to a menu program. At some levels, when prompted for data entry, the user must enter the requested data in the proper format or he will not be permitted to continue. An error message such as: "INVALID LAYER DATA: RENTER!", will be displayed. The user would remain in this state until the proper data was entered or until the escape sequence (!<CR>) was executed. [Ref. 4: pp. 68-69]

4. Menu Structure

The ITDA menu structure is organized in the form of a hierarchical system with the selection of a menu item from one level leading to another set of menu options, and so on. Appendix E, ITDA CDA-TREE, shows how this structure is set

up. The assignment of menu items to the key positions or numbers is based on frequency of use. Those items most often used are assigned item number 1, the next most often used is assigned item number 2 and so on. [Ref. 6] Therefore the same menu item name such as "SURFACE" will not always be assigned to the same item number. The number of menu options available varies from two to a maximum of eight. Some menu programs have gaps between the selections. For example: items 1, 2, and 3 may be used, 4, 5, 6, and 7 not used and item 8 used. This provides some standardization in that some keys are always in the same position, key number 8 is primarily the "EXIT" key which will take the program back up one level. Figure 2.2 shows an example of the menu program from the Main Menu through the first two levels of the "CONTACTS" module. Selection number 1 of the first level, leads to the second level and selection number 1 of the second level leads to the third. Notice the letters SFK above each menu line. This indicates that the Special Function Keys may be utilized with in this menu program.

SFK

1 CONTACTS	2 WARFARE	3 GENERAL SUPPORT		5 STAND ALONES	6 UNIX SHELL	7 ADE	8 EXIT

SFK

1 INPUT CONTACT	2 MODIFY CONTACT	3 PLOT CONTACT			6 BUILD ELLIPSE		8 EXIT

SFK

1 SUBSURF	2 SURFACE	3 AIR					8 EXIT

Figure 2.2 Menu Program Example

E. SUMMARY AS APPLIES TO VOICE APPLICATION

The following characteristics of the ITDA are of particular interest when applying it to a Speech Recognition System as in the context of this study:

- The ITDA was not designed to be operated from a remote terminal.
- The same menu names are not always assigned to the same item number.
- Gaps are present in some of the menu programs.
- Prompts to the user for data input are displayed on the graphics screen.
- Multiple commands cannot be given, the menu must refresh itself completely before the next selection can be made.

The description of how these characteristics affect the application of Speech will be discussed in later chapters.

III. AUTOMATIC SPEECH RECOGNITION SYSTEMS

A. OVERVIEW

Speech recognition systems can be categorized by combinations of four generic types. The first breakdown is that of speaker dependent versus speaker independent. A speaker dependent system takes samples of the potential user's voice, stores them in memory, and uses that stored "voice" data in making comparisons and recognitions. A speaker independent system has algorithms which supposedly handle many different voice patterns. It need not be trained by the user and should be able to recognize the voice of anyone who uses it.

The second generic breakdown of speech recognition systems is that of discrete versus continuous speech. A discrete system can only recognize one word or phrase at a time. The word/phrase must be spoken in a continuous phrase of sound. The user must pause approximately one tenth of a second between words/phrases. This pause tells the recognizer that the word is over and it then will search for a match. With a continuous speech recognizer the user speaks more naturally with no artificial pauses or breaks. The recognizer distinguishes the various words or phrases and compares them to stored data for the match. The discrete system is better for single inputs such as a menu driven program. The continuous speech system is better when longer strings of data are being entered to the computer such as latitude and longitude coordinates. The continuous speech recognition system creates a more natural man-machine interface and works equally well in a discrete mode. [Ref. 3: p. 1]

There have been over 35 different theses, reports and experiments conducted at the Naval Postgraduate School related to speech recognition and its applications. From this

work the following conclusions can be drawn. Voice input can be much faster than manual, fewer mistakes are made and operators perform up to 25% more work on additional tasks while using voice input on the primary task. [Ref. 7] The amount of stress and workload put on the operator has an effect on the accuracy of the Speech Recognition Device (SRD). Increased mental workload can cause an increase in errors, however through careful vocabulary selection this error increase can be minimized. [Ref. 8] Increased stress also increases errors. This can be minimized and even eliminated by training the SRD under the same level of stress as is expected during operations or training with composite samples from several different stress levels. [Ref. 9] Operators of SRD may not need a lot of training in the use of the SRD. In one study, first time users achieved at least as high of recognition accuracy as those who had been trained and had practiced using the device. [Ref. 10] Another study showed that after only two weeks of experience the error rate of users decreased significantly and that generally speaking, experienced users of SRD have better recognition accuracy. [Ref. 11] In relation to the several months it takes to train an operator on the ITDA, the additional two weeks to become familiar with a SRD is not too great a burden.

There are two types of errors with respect to SRDs. The first being that of non-recognition. This is where the system does not make a match which, in a sense, is the same as not hearing the phrase. The second is that of mis-recognition, that being the case when the SRD makes a match but matches the wrong phrase. The first type can primarily be attributed to the operator not saying the phrase the same way that it was trained or saying a word that is not in the vocabulary. The second error is primarily attributed to vocabulary selection, having words or phrases that are very similar to one another.

B. VOTAN SPEECH RECOGNITION SYSTEM MODEL 6050 SERIES II

The VOTAN VTR 6050 Series II (VOTAN) is a speaker dependent, continuous speech recognition system. It is a convenient, portable, stand alone unit which can be connected to any system using a standard RS-232 port. Its output is standard ASCII or hexidecimal equivalent. It operates in two different modes: Voice Terminal (VTR) and Voice Peripheral (VP). The VTR mode is a direct interface between the host computer and terminal. This is the mode used in operating the ITDA through the HP 9020 host. Figure 3.1 shows the configuration for operating the ITDA with the VOTAN. The VP mode is used for telephone applications and is not discussed further.

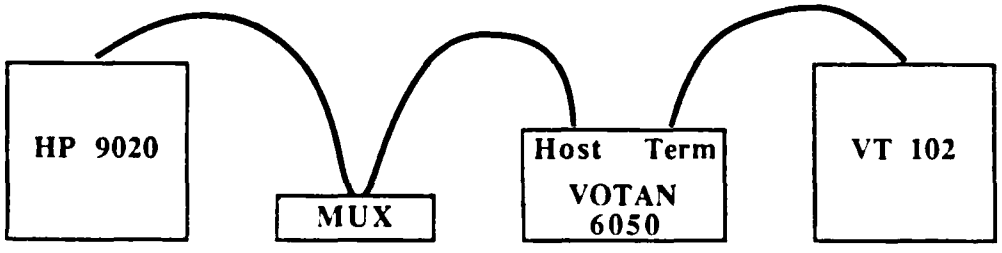

Figure 3.1 Configuration to run the ITDA with VOTAN

1. Capacity

The storage capacity of the VOTAN is supported by three internal components. They are:

- VTR System Memory (approximately 500K)
- Floppy Disk Memory (maximum of 760K)
- Voice Card Memory (maximum of 22K)

Additional storage capacity can be obtained by storing voice data in the host computer. The average word will use 200-250 bytes of memory, for 1 pass training (multiply that amount by the number of training passes or templates desired). More templates give a higher recognition accuracy. The VTR System Memory can hold 2000-3000 words, depending on the number of

templates. The Voice Card can hold only one set at a time. The maximum number of word templates per set is 150. The recommended number of words is 10-20. [Ref. 12: pp. 1.11-1.12] Since the VOTAN searches all available templates to insure an accurate recognition, fewer words in the set will increase the speed of the recognition. The smaller sets take up less memory thereby providing more space for multiple training passes which will increase the accuracy of recognition.

The System Memory can hold multiple sets. The VOTAN will switch from one set to the next instantaneously. [Ref. 12: p. 1.11] The switch is accomplished in one of two ways. The first by using a switch word, where a word or phrase is recognized and the system is told to load the new set on the voice card. The second is by setting a predetermined number of recognitions from the on-line set after which the switch takes place. In order to effect the switch, when using a switch word, the set label must be included in a "COMMON" set. The common set is active, on the Voice Card, at all times.

There are certain words reserved by the VOTAN as task words. The following is a list of the VOTAN task words with their associated tasks.

- GO TO SLEEP	Stop recognizing.
- LISTEN TO ME	Start listening again.
- INITIALIZE	Start recognizing from the set specified by the SYS command. Clear the message and data buffers.
- VERIFY	Play all the messages in the message buffer.

This task word set is also active on the Voice Card at all times. [Ref. 12: p. 1.11]

2. Programming

The VOTAN is designed to be easily programmed. Crucial to the successful implementation and operation of the system is the careful planning and selection of a vocabulary so as not to exceed memory and to minimize set switches, the

latter not as critical as the former. It must be remembered that the Voice Card is limited to 22K, which includes all common and task words as well as the active set. For example, if your file contains 10 sets, each with a COMMON identifier, Those 10 COMMON words will occupy 10 spaces on the Voice Card. The 4 Task Words will occupy another 4 spaces therefore the Voice Card will start out with 14 words before a set is ever loaded to the card. Assume that each of the above 14 words or phrases take 500 bytes, you will have used 7K of the possible 22K. With the size of the ITDA vocabulary it is possible to exceed the 22K with just set labels. For this reason the vocabulary is broken into several files, each file further broken into sets. The separate files need to be restored manually.

The VOTAN is programmed in the off-line mode. This mode does not permit the transfer of any commands to the host, and is primarily used in the programming and training phases. There are several commands used in programming the VOTAN. The following example gives a brief description of those used in the application described in this thesis. All programming is done from the VT 102 terminal. The user first enters the edit mode by typing edt, he then enters the set label and subsequent word/phrases in that set with their associated host strings. The following is an example of programming the VOTAN.

```
EDT                          {allows you to enter the EDITOR}

S:EXISTING_CONTACT,CM        {identifies the set as
                              EXISTING CONTACT, and puts it in the
                              COMMON (CM) set}

EXISTING_SUBMARINE,HS=11\0D  {EXISTING SURFACE is the
                              prompt, the commands sent to the host
                              are 11 followed by a carriage return,
                              hexidecimal \0D}

DELETE_DATA,HS=  \0D         {the host string in this case
                              is two spaces and a carriage
                              return, the hexidecimal
                              representation for space could
                              also have been used}

S:NUMBERS,CM                 {identifies a new set, NUMBERS,
                              which again is a common word}
```

ONE,HS=1	{ONE is the prompt and a 1 is sent to the data buffer}
TWO,HS=2	{TWO is the prompt and a 2 is sent to the data buffer}
THREE,HS=3	{similar to above}
POINT,HS=.	{POINT is the prompt and a period is sent to the buffer}
ENTER,HS=\0D,SD	{a carriage return is sent to the buffer and then all data in the buffer is sent to the host computer}
FORGET_IT,CD	{the word to clear the data buffer is FORGET IT, this would be used if an error was made, the data would be deleted before it was sent to the host}
SDB1	{turns the data buffer on, must be give at the executive level after a V> prompt}

A complete listing of the VOTAN programming commands is found in the Users Guide which is reference 14. Appendix B and Appendix C gives a listing of the vocabulary for use with the ITDA. The vocabulary will be discussed in Chapter IV, Vocabulary Selection.

3. Training

The single most important factor in achieving recognition accuracy is that of training. [Ref. 3: p. 3] The VOTAN can be trained in two different modes, Single Pass and Training In Phrases. In the single pass mode, the VOTAN helps the user train each word, one time. The single pass training can then be repeated as many times as the user would like. It is recommended to have at least two passes but no more than five. [Ref. 12: p. 2.3] More passes gives the VOTAN that many more templates from which to make a comparison and a match. More training passes equates to greater accuracy. It is in the single pass mode that a composite template can be created. Each pass can be made at various levels of operator stress to develop a template that will serve equally well under various stress levels. A composite template using many different users can also be developed in this mode. Studies have shown that speaker dependent systems can very closely simulate speaker independent systems by composite training.

Accuracy was maintained at 99% when the speech patterns of four different users were combined with the primary user, and over 95% when four users created the composite template and a fifth user attempted the recognition. [Ref. 13] This would be especially useful in time critical situations where there just is not enough time for all potential operators to train their own vocabularies. In the military, with the frequent rotation of operators due to transfers, it would be useful to have a composite template for the in-coming operator. Other useful applications of this principle are in cross training, the inexperienced operator can add his training templates to the experienced one, both can operate the system simultaneously without changing disks or files.

The Training In Phrases mode requires that at least two passes have been made with the single pass mode. In this mode the VOTAN selects several words to be trained in a phrase. In some situations this is much more accurate because it more closely resembles the way the operator will speak during operation. In normal conversations some words tend to get slurred, the slurred word may not be close enough to the one trained to get a recognition. In these cases the Training In Phrases is very beneficial. [Ref. 12: p. 2.4] The VOTAN has an algorithm which selects the words for each phrase. Each phrase will consist of several words. The user will train the phrases by saying the words in the order presented. Each word will get trained at the beginning of the phrase, in the middle of the phrase, and at the end of the phrase. This type training also takes care of the various voice inflections that occur naturally by the position of the word in the phrase. Training In Phrases is time consuming and memory consuming. If the users vocabulary is not experiencing recognition problems there is no need for this type training. If only a portion of the vocabulary is questionable, that portion may be trained separately by the phrase mode. [Ref. 12: p. 2.5]

Good training habits should be developed and enforced. One study demonstrated that operators who are supervised throughout the training process achieve better recognition rates than those who train by themselves. [Ref. 3: p. 4] Training should be done in the same environment as is expected for operations. The voice should be warmed up but not tired, conduct the training at midday. [Ref. 12: p. 2.3] A test of this principle was conducted during this thesis research. The demonstration vocabulary was trained at midday and exercised at various times throughout the day with no significant differences in the dist1 (described in chapter IV) recognition level. All distances were in the mid 20 range. The same vocabulary was retrained at 2200 hrs and exercised at 1000 hrs the following day. In all cases the dist1 recognition level increased by at least 10 points, and for many words as much as 20 points. Another test, an unintentional test of recognition was also completed. That being, how a head cold with nasal congestion affects recognition. The following observation is made: When the vocabulary was trained without a cold, and exercised with a cold, there was no significant difference in the recognition levels. When the vocabulary was trained with a cold and exercised without a cold, there was a significant difference in the dist1 recognition level. There is no scientific or statistical data to support this, it is merely an observation.

When training, do not shout or exaggerate the words, attempt to speak in as normal a pattern as possible. Voice patterns do not change significantly over time, however it is recommended to retrain approximately every six months. This is not critical in that a study was done with voice patterns that were five years old and recognition accuracy did not decrease at all. [Ref. 14]

Basic training techniques and habits are summarized as follows:

- PLAN HOW YOU WILL SAY EACH WORD AHEAD OF TIME.
- TRAIN UNDER THE SAME CONDITIONS THAT YOU WILL OPERATE IN.
- SPEAK NORMALLY, WITH NO SPECIAL INTONATION OR ENUNCIATION.
- USE A CLEAR, FIRM TONE. DO NOT EXAGGERATE THE WORD.
- TRAIN EACH WORD AT LEAST TWO TIMES.
- USE THE LEAST NUMBER OF TEMPLATES THAT WILL GIVE ACCURATE RECOGNITION.
- IN NOISY ENVIRONMENTS ADJUST THE GAIN TO BLOCK OUT BACKGROUND NOISE.
- TRAIN AT MIDDAY, WHEN THE VOICE IS WARMED UP BUT NOT TIRED.
- WHERE POSSIBLE, RETRAIN EVERY SIX MONTHS.

4. Operation

When the VOTAN is first turned on, it comes ON-LINE. It is in this mode that communication with the host computer is accomplished. The user must first take the VOTAN off-line and select which file he would like to have activated, he restores that voice data to the Voice Card then puts VOTAN back on-line and operation can begin. Some commands can be programmed to happen automatically each time the VOTAN is INITIALIZED. The set to be restored to the Voice Card is one such command. Another is the use of the Data Buffer as indicated in the above example. The Data Buffer is very useful, especially where accuracy is critical. The SRD may be 100% accurate but if the operator says the wrong thing, an error is still made. By using the buffer this type of operator error can be corrected. The use of these automatic commands would have to be considered for each application and may not be appropriate for some. Once on-line the commands are sent directly to the host. The keyboard can also be used to input data and in some situations a combination of voice and manual input may be best. Such would be the case with the ITDA, when entering new contacts, where the name of the contact may not have been stored or trained.

5. Interface with ITDA

The hardware interface between VOTAN and the ITDA is accomplished as per Figure 3.1. The software interface is much more complicated. As was pointed out in chapter II, the ITDA was not programmed with the application of voice in mind, or with the possibility of being operated by a remote user. This fact has created some significant problems, not all of which were able to be overcome. The Air Force recently conducted a study of applying speech recognition to a Weapons Control Station. They faced a similar problem, the original software was not developed with a speech application in mind. The software was not expecting input through a host port, the port that the SRD was connected to. They solved their problem by changing the software. [Ref. 15: pp. 24-28]

VOTAN is treated as a remote user, and as such must input data through the MUX card. Data sent through the MUX card is not expected by the ITDA and not accepted until a carriage return is sent. Since a carriage return is one method of selecting menu items from ITDA, the required carriage return <CR>, was not only sending the data but also executing the next highlighted menu item when it was not wanted. This was overcome by using a combination of numeric entries and "space bar" followed by a <CR>. For example, to execute key number 8, the command would be 7 spaces and a <CR>. The 7 spaces would move the highlighted item from block 1 to block 8, the <CR> would send the data through the MUX card and also execute item 8. For multiple commands, only the last level of commands need use the "space bar" <CR> method. For example, the key strokes or menu item numbers to input an "AIR" contact in the CONTACT module would be 113. The VOTAN command line would be: 11++\0D, where the "+" sign represents a hit on the space bar, and the "\0D" is the hexidecimal representation for a carriage return. No generalizations can be made using the "space bar" <CR> method. Many times in the ITDA flow chart there are gaps in the menu. Gaps are where

item numbers are skipped, such as: 1, 2, 3, are used 4, 5, 6, are skipped, and 7 and 8 are used. In this case only 4 spaces and a <CR> would cause item number 8 to be executed. This same problem prevents the use of just one set, the set of numbers 1 to 8, and using voice to step through each level one at a time, the same as with manual input. This last method, the single set of numbers 1 to 8, would be a good alternative when the carriage return problem is solved. Programmers at NADC indicate that this could be done. [Ref. 16] It was not done nor was the possibility able to be verified under the constraints of this work.

A problem much greater than the <CR> is the lack of required prompts to the operator on a remote terminal. The VOTAN makes the input through the MUX card and the graphics are manipulated on the HP 9020 screen. All operations appear normal until the program reaches a point where the operator must enter data other than simple menu items. The prompts to the operator are not displayed, he is faced with a static screen, with no menu items to choose from. As was pointed out in Chapter II, there is no graceful exit from some levels, either the operator makes the required data entries in the proper format or he is told "INVALID DATA, REENTER" in this case he doesn't even get the error message. There currently is not a solution to this problem, other than the operator being so familiar with the program that he knows what is wanted at all times. Through careful vocabulary selection this problem can be minimized but still requires a very familiar operator. The "BREAK_OUT" phrase is included in the vocabulary with the associated key strokes which will get the operator out of the situation just described, it will not however get him the prompts. This problem was also described to the programmers at NADC, who once again felt that the corrective action might not be too difficult. [Ref. 16]

The final problem associated with this particular application of a Speech Recognition System is that of

multiple meaning words. There are several words which are used quite often in the ITDA. The problem lies in that the same key strokes are not associated with those words each time they are used. For example the word "SURFACE", has a keystroke of 2 assigned in one occurrence and a 3 in another. This prevented the use of a "Frequently Used" word set. Additionally VOTAN will not permit the use of multiple meaning words at all within the same file even with set separations. To overcome this, each occurrence of the word had to have a spelling variation. The word was spoken the same way each time in training and in recognition but the proper keystrokes would be associated with the proper occurrence of the word because of the set separation. The above manipulation is possible only because the words are separated by sets and only one set is active on the Voice Card at a time. Therefore there is no chance of mis-recognition between the two words. Detailed examples are given in Appendix C. for the word "EXIT".

VOTAN is able to give multiple commands to the ITDA, however because of the present software only one command is executed at a time. The difference between manual and voice operation is that the manual operator must wait for the menu to refresh itself before entering the next command. The voice operator's commands are buffered in the VOTAN and are sent and executed on the very instant that the menu is refreshed. The voice operator sees the menu items flash on the screen as the multiple commands are executed.

IV. VOCABULARY SELECTION

The selection of the vocabulary is important in several aspects. First, the accuracy of recognition is affected by word selection. Under periods of increased mental workload, the greater number of errors occur between words that are similar. [Ref. 17] Multi-syllable words are better than mono-syllable words. [Ref. 12: p. 2.4] The SRD takes the voice data, compresses it and then analyzes each part and compares it to stored data, the more parts to compare with, the greater the recognition accuracy. Finally the man-machine interface is affected by the vocabulary chosen. Words or phrases should be selected so that the user feels most comfortable, vocabularies should be tailored to individual users desires.

Vocabulary selection probably ranks equally in importance with vocabulary training. [Ref. 3: p. 4] With the size of the ITDA vocabulary it is critical to successful implementation that the vocabulary be carefully planned and selected. It has been pointed out that similar words can cause errors in certain situations. There are obvious similar words such as "no" and "go", but other words which do not seem similar to the human ear do get mis-recognized in the VOTAN "ear". [Ref. 12: p. 2.7] VOTAN provides a measuring device by which these similar words can be detected and changed in order to enhance the recognition accuracy. That device is the Acceptance Level. The Acceptance Level is a measure of how closely what is said matches a template that is stored. A 0 (zero) is an exact match and a 255 is the worst case, where anything said is recognized. [Ref. 12: pp. 2.6-2.7] The user establishes the level of recognition which will be accepted. That level is currently set at 50 and for most applications is acceptable. When exercising the vocabulary, each word is listed with a dist1 and dist2 acceptance level. The dist1 is

the closest word and the dist2 is the next closest. By comparing these two levels, potential mis-recognitions can be identified. Figure 4.1 is an example of the dist1 and dist2 acceptance level display for the ITDA vocabulary.

005 NUMBERS	dist1=024	039 NEW_CONTACT	dist2=071
006 ONE	dist1=026	016 NORTH	dist2=048
014 NINER	dist1=032	022 ENTER	dist2=036
037 EDIT	dist1=006	038 EXIT	dist2=030

Figure 4.1 Acceptance Level Display

For best recognition, the dist1 acceptance level should be between 20 and 30. As can be seen by this example, some pairs of words are more similar than others. On the first line, the word NUMBERS was spoken and recognized with a dist1 of 24. The next closest word was NEW_CONTACT at a distance of 71. The recognition differential between the two is good. The greater the distance, the better. Word number 014 NINER, has a dist1 of 32 and is very close to the dist2 word of ENTER. These two words are prime candidates for mis-recognition. To correct the situation, one of the words could be changed, the words could be isolated by set separations, or attempt the Training In Phrases solution. Word 037 EDIT and word 038 EXIT, sound very similar, but to VOTAN the recognition difference is very great. Notice that it is possible for both the dist1 and dist2 word to be below the recognition acceptance level of 50. This does not create a problem as long as the distance difference is acceptable. The user decides what is acceptable based on the application. For use with the ITDA a difference of at least 10 is acceptable. The recognition acceptance level can be changed to suit the situation. It is currently set at 50 which is to say that if the dist1 is not 50 or less there would not be a recognition. In applications where absolute accuracy is required, the

level can be set much lower. Lowering the level will reduce the mis-recognition errors but may increase the non-recognition errors. After exercising the vocabulary several times if a trend is established such that the dist1 levels do not go above a certain point, then the recognition level should be lowered to that point. Selecting a vocabulary is an evolutionary process. The user is advised to change and update the vocabulary with words and phrases that improve the dist1 and dist2 differences.

Words should be selected which will give the user a clue as to what functions will be performed as a result of saying that word/phrase. The length of the word or phrase affects recognition. Multi-syllable words are better than mono-syllable. Longer words/phrases provide more distinctive information which VOTAN uses to make comparisons. (Ref. 12: p. 2.4) With the ITDA, attempt to use the entire menu item name, such as "DELETE ALL BEFORE TIME". A drawback to the long phrases is that they are difficult to say the same way twice. This example could be shortened to "DELETE ALL BEFORE", without losing any recognition accuracy and still maintaining meaning. Appendix C should be consulted. It contains a summary of tools for developing a vocabulary and the actual vocabulary selected for the CONTACTS module.

In the application described in this thesis, that of running the ITDA with the VOTAN, the following were considerations in vocabulary selection. By studying the CDA TREE in Appendix F, one can see that there are many changes in the various categories, these are very convenient for set and file selection and breakdown. One can also see that there are several instances where the same word or phrase has different commands associated with it. This causes significant problems if those words are not separated by set selection or even separate files. An example is in the CONTACTS module, under INPUT CONTACT. The word SURFACE is menu item number 1, and requires a 1 to be sent to the host.

Under MODIFY CONTACT, the same word, SURFACE, is menu item number 3 and requires a 3 to be sent to the host. The VOTAN will not permit programming the same word with multiple meanings, another word could be substituted for one of the SURFACE words but that could lead to confusion and errors on the part of the operator. It is best to separate these occurrences by sets. There are several words or phrases that are similar. In the CONTACTS module, under PLOT CONTACT are the phrases PLOT ALL and PLOT AIR. The word AIRCRAFT was substituted for the word AIR, and it is just as natural for the operator to say AIRCRAFT which makes this a good substitution. There are other similarities such as ACCEPT DATA and EDIT DATA, ALL SUB and SPEC SUB. There are different ways to deal with each situation, sometimes by deleting the word that is the same, in this case DATA, the problem is eliminated. In all cases where an abbreviated word is used, by saying the whole word, such as SPECIAL SUBMARINE instead of SPEC SUB, the problem is eliminated.

The application of speech recognition to the ITDA is not restricted to the VOTAN 6050 series II recognizer. Any SRD can be used as long as the output string is ASCII and/or hexidecimal and the connecting hardware is a standard RS 232 cable. If the SRD does not have the set switching features of the VOTAN, it must have a very large capacity for the vocabulary.

V. SCENARIO APPLICATION

A possible application of speech recognition with the ITDA is that of operating it in a predetermined scenario. This type application would be useful and effective in situations where the type of information needed from the ITDA as well as the order in which it would be requested was known in advance. Examples of this type scenarios are: Presenting status reports; Recommended Sonobuoy placements for a given situation; and Sequence of events supporting an upcoming exercise.

To present a status report to a Battle Group Commander the user would program the voice commands the execute the key strokes which would adjust the geoplot to display the geographic locations of all vessels in that battle group, all enemy vessels within the radius of concern, and current readiness posture. For placement of sonobuoys, the user would program several generic type tracks and assign those corresponding key strokes to specific phrases, when a particular track is encountered, the user simply says the phrase which corresponds to that track and the recommended pattern would be displayed.

Pre-programming for specific or generic scenarios can also be accomplished. Certain operations routinely encounter similar if not the same situations. Appendix E is an example of one such scenario. During the execution of the ITDA program in this particular scenario, the ITDA operator is free to move around the Command Information Center, (CIC), and can be accomplishing additional tasks such as maintaining a message traffic log. The total number of manual key strokes to run this scenario is ___, the total number of voice commands to run the same scenario is ___. The time to execute this scenario manually was approximately 14 minutes, by voice 7 1/2 minutes.

Many other operational oriented scenarios and routine tasks can be developed. The development being limited only by the imagination of the operator. Each of the above type applications have their own advantages. However, they all have the following in common. The voice application is faster, is more efficient in terms of man hour usage, and is more accurate.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The complexity of the Command, Control, and Communication (C3) system will be multiplied many times by the added pressures of combat. The commander who makes the most efficient use of his assets in Directing, Coordinating, and Controlling forces will gain the advantage over his opponent. The Computer Assisted Decision Aid has evolved into an essential component of the C3 system. Just as essential is the man_machine interface with the computer. The application of Speech Recognition Devices to military systems is a potential 'high pay-off' asset which will give the commander the advantage. [Ref. 15: p.25]

This thesis investigated the advantages of SRDs in the C3 environment and its application to the Integrated Tactical Decision Aid. Users of SRDs have demonstrated that information can be processed more rapidly and with less errors, that operators can accomplish more work and have greater flexibility to accomplish more than one task. In modern combat one cannot afford the luxury of a dedicated keyboard operator, he must be able to do many things simultaneously. SRDs give this added flexibility.

The ITDA is a valuable decision aid currently in use. The combination of speech technology with the ITDA would be a quantum leap forward towards achieving maximum efficiency in the man-machine interface. The VOTAN 6050II SRD was connected to the host computer for the ITDA. The ITDA was operated by voice with a great deal of success. As the ITDA currently exists an ideal interface is not possible. Ideal being that the operator workload, both mental and physical, would be reduced by the addition of speech. With the current application, critical prompts to the operator are lost which would increase the mental workload, forcing the operator to

memorize what prompts should appear to him for the entry of data. Programming the VOTAN to operate the ITDA is awkward with the present software, requiring much trial and error and voice command manipulation.

B. RECOMMENDATIONS

The application of speech recognition to the ITDA should be pursued. The required changes in the ITDA software, should not affect the manual operation of the program and could be relatively easy to do. NADC is the controlling agency for the ITDA, future studies with this application should be directly with them. Speech Recognition is the ideal interface with machines and is the technology of the present and future, therefore developments of and modifications to existing decision aids should be conducted with the application of speech technology in mind.

APPENDIX A
ITDA MODULE DESCRIPTION

The following description of the ITDA modules is an extract from Appendix A, Module Description, [Ref. 4].

- AAW — From the main display selection menu of the Antiair Warfare (AAW) tactical decision aid, options exist to display tracks, PIMs, and associated graphics. Algorithms for intercept and stationing problems are provided. Graphics displays enhance the information presented. The action functions are used to quickly change the display, measure range and bearing between points, or to compute stationing times based on time of arrival computations.

- ASW — The Antisubmarine Warfare (ASW) allows analysis for localizing and engaging a submarine.

- ASUW — The Antisurface Warfare (ASUW) module allows the user to plan and monitor the assignment of surface surveillance aircraft to achieve surface search and localization objectives in the vicinity of a Battle Group, and to plan or simulate the engagement of surface contacts.

- EW — The Electronic Warfare (EW) module enables calculation and display of satellite information, aircraft coverage altitude, environmental effects on radio frequency propagation, and the effect of terrain masking (shadowing) on radar detection of a surface vessel.

- CONTACTS — This module allows the operator to input, modify, delete, and plot contacts, and includes the capability to generate ellipses, given two or more bearings for a contact.

- ASODA — The Automated Strike Operations Decision Aid (ASODA) assists the Strike Operations Officer and his staff in the performance of their duties, ranging from routine functions to operating in a contingency tasking and planning role. Functions within ASODA are: executive control, administrative support, force management, mission planning, schedules, and weapons employment effects.

- COPS — The Communication and Planning Support (COPS) program is designed to assist the Navy communications community in forecasting HF propagation. This module allows shipboard communications personnel to determine the coverage of an intended HF emission as a function of power, frequency, location (distance), time of day, and solar activity.

- PANDA — The Pattern Analysis Decision Aid (PANDA) is designed to provide assistance to an antisubmarine warfare (ASW) analyst in determining optimal sonobuoy search pattern geometry, spacing, and orientation given the prevailing environmental conditions and current knowledge of probable target characteristics, location and movement.

- SASHEM — The SAG or SAG HARPOON Engagement Model (SASHEM) provides for the evaluation of multiple shooter versus multiple target HARPOON tactics. Probabilities of target acquisition (PACQ) and of weapon hit (PHIT) are calculated and displayed. PACQ algorithms account for environmental effects, target motion, and target location errors. The PHIT calculation is based on extensive Soviet Antiship Missile Defense (ASMD) information. For each of the Soviet ship classes in the database, the effectiveness of search radars, ESM suites, and hardkill ASMD systems against each HARPOON missile block are considered. SASHEM is accessed through ASUW.

- TEPEE — The Tomahawk Engagement Planning and Exercise Evaluation (TEPEE) module produces Tomahawk Antiship Missile (TASM) engagement plans which replicate engagements designed on the Tomahawk Weapon Control System (TWCS), by using the same algorithms. An operator can, therefore, be confident that an engagement designed on the TWCS can be produced on the TEPEE and vice versa. TEPEE goes beyond just producing TASM engagement designs. TEPEE allows: exercise reconstruction and evaluation of engagements, scenario generation, HARPOON missile engagement training, and automatic data entry.

- ADE — The Automatic Data Entry (ADE) module is designed to manage the receipt and processing of OPINTEL, oceanographic, and LINK 14 messages. It contains facilities to log incoming messages, view messages, and plot contact data they contain, and to manage up to sixteen communications channels.

- FEATURES — The Feature Build decision aid is used to create special map areas, known as features, to represent operational areas, rendezvous areas, etc., which the operator defines to meet the specific needs. In addition to the ability to specify geographic areas, the operator can define start times and stop times for each area so that the various areas can turn on or off automatically. Individual map features have unique names and can be polygons or circles. Features are organized into groups, with each group residing in a separate database.

- PORTS — The Modify Ports decision aid of the General Support module is used to display ports on the geoplot. The operator has the capability to:
  Define the location of a port,
  Assign a name to a port,
  Assign a symbol to mark the port,
  Assign a color to a port symbol and name.
  Ports data can be entered, modified, or deleted at the discretion of the operator. Once entered, ports can be displayed on the geoplot by using the Special Function Keys.

APPENDIX B
PREPARING THE VOTAN AND INTERFACING WITH ITDA

This appendix illustrates how to put the VOTAN into operation with the CONTACTS module of the ITDA. The vocabulary here is the recommended one for use with the current version, 2.0, of the ITDA housed in the HP 9020 and the VOTAN 6050 II. The entire vocabulary for the CONTACTS module is contained in Appendix C.

A. PREPARING AND PROGRAMMING THE VOTAN

Connect the VOTAN to the HP 9020 by way of the RS 232 ribbon cable, one end to the HOST port on the VOTAN the other to the MUX CARD, second port. Connect the VOTAN to the terminal by way of another RS 232 cable, one end to the TERMINAL port of the VOTAN the other to the VT 100/102 terminal itself.

To program the VOTAN and train the vocabulary, only the terminal and VOTAN itself are used. Turn on the power to the VOTAN and terminal. The following will be displayed if the connections have been made properly:

```
VOTAN Voice Terminal V5.1
  - On Line -
```

Take the VOTAN off-line by holding down the CONTROL key and pressing the "b" then "a" keys, the following will be displayed:

```
  - Off Line -
V>
```

The VOTAN is now ready for programming. The V> prompt is the executive level prompt. The commands used here have been described in chapter III. For a more complete description see the users guide. Enter the following just as it is listed here. The use of upper or lower case characters does make a difference, you can use either, just remember which for the purpose of restoring your file.

```
EDT             {END THIS AND EACH OF THE FOLLOWING LINES WITH A
                CARRIAGE RETURN}

S:NUMBERS,CM
ONE,HS=1
TWO,HS=2
THREE,HS=3
FOUR,HS=4
FIVE,HS=5
SIX,HS=6
SEVEN,HS=7
EIGHT,HS=8
NINER,HS=9
ZERO,HS=0
NORTH,HS=N
SOUTH,HS=S
EAST,HS=E
WEST,HS=W
BREAK OUT,HS=!\0D
MAIN MENU,HS=\1BS
ENTER,HS=\0D
EXECUTE,SD
DELETE,CD
S:MONTHS,CM
JANUARY,HS=JAN
FEBRUARY,HS=FEB
MARCH,HS=MAR
APRIL,HS=APR
MAY,HS=MAY
JUNE,HS=JUN
JULY,HS=JUL
AUGUST,HS=AUG
SEPTEMBER,HS=SEP
OCTOBER,HS=OCT
NOVEMBER,HS=NOV
DECEMBER,HS=DEC
S:NAMES,CM
NIMITZ,HS=NIMITZ
NEW JERSEY,HS=NEW JERSEY
MISSOURI,HS=MISSOURI
RED ONE,HS=RED ONE
BLUE TWO,HS=BLUE TWO
S:EXISTING CONTACT,CM,NS=NUMBERS,CT=1
EXISTING SUBMARINE,HS=11\0D
EXISTING SURFACE,HS=11+\0D    {THE "+" INDICATES A SPACE}
EXISTING AIRCRAFT,HS=11++\0D
S:REPORT TYPE,CM,NS=DATA,CT=1
POSITION,HS=\0D
DATUM CIRCLE,HS=+\0D
LINE OF BEARING,HS=++\0D
RANGE,HS=+++\0D
CONTROL ZONE,HS=++++\0D
ELLIPSE,HS=+++++\0D
SOSUS BOX,HS=++++++\0D
-EXIT,HS=+++++++\0D
S:DATA,NS=COMMON,CT=1
ACCEPT,HS=\0D
EDIT,HS=+\0D
DELETE,HS=++\0D
EXIT,HS=+++\0D
S:NEW CONTACT,CM,NS=COMMON,CT=1
NEW SUBMARINE,HS=1\0D
NEW SURFACE,HS=1+\0D
NEW AIRCRAFT,HS=1++\0D
S:CONTACT TYPE,CM,NS=COMMON,CT=1
FRIENDLY,HS=\0D
HOSTILE,HS=+\0D
NEUTRAL,HS=++\0D
BATTLE GROUP,HS=+++\0D
EXERCISE ENEMY,HS=++++\0D
```

```
UNKNOWN,HS=+++++\0D
EXIT-,HS=++++++\0D TOP OF MENU
S:SPECIAL-FUNCTIONS,CM
TOP OF MENU,HS=\1BS
MAP-OPTIONS,HS=\1BP
PLOTS,HS=\1BQ
TRACK DESIGN,HS=\1BR
HELP,HS=\1BT
MAP TOGGLE,HS=\1BU
TIME CHANGE,HS=\1BV
SCREEN MANAGEMENT,HS=\1BW
S:LATEST HARD COPY,CM,NS=CONTACT_TYPE,CT=2
LATEST CONTACT,HS=21\0D
ALL OF THEM,HS=\0D
SUBMARINES,HS=+\0D
SURFACE,HS=++\0D
AIRCRAFT,HS=+++\0D
S:HARD COPY CONTACTS,CM
ALL SUBMARINES,HS=21+\0D
SPECIAL SUBMARINE,HS=21++\0D
ALL SURFACE,HS=21+++\0D
SPECIAL SURFACE,HS=21++++\0D
ALL AIRCRAFT,HS=21+++++\0D
SPECIAL AIRCRAFT,HS=21++++++\0D
S:DELETE OPTION,CM
DELETE,HS=2+\0D
ALL OF THEM,HS=\0D
S:ALL OPTIONS,CM
-SUBMARINE,HS=+\0D
-SURFACE,HS=+++\0D
-AIRCRAFT,HS=+++++\0D
-DELETE-ALL,HS=\0D
ALL BEFORE,HS=+\0D
S:SPECIAL OPTIONS,CM
SPECIAL SUBMARINE,HS=++\0D
SPECIAL-SURFACE,HS=++++\0D
SPECIAL-AIRCRAFT,HS=++++++\0D
DELETE REPORT,HS=\0D
-ALL BEFORE,HS=+\0D
-DELETE ALL,HS=++\0D
S:EDIT OPTION,CM
EDIT,HS=12++\0D
--SUBMARINE,HS=\0D
--SURFACE,HS=+\0D
--AIRCRAFT,HS=++\0D
EDIT LINE,HS=\0D
EDIT NAME,HS=+\0D
EDIT TYPE,HS=++\0D
EDIT ID CODE,HS=+++\0D
LIST CONTACTS,HS=++++\0D
S:PURGE OPTION,CM
PURGE,HS=2+++\0D
-ALL OF THEM,HS=\0D
-ALL-SUBMARINE,HS=+\0D
-SPECIAL SUBMARINE,HS=++\0D
-ALL SURFACE,HS=+++\0D
-SPECIAL SURFACE,HS=++++\0D
-ALL AIRCRAFT,HS=+++++\0D
-SPECIAL AIRCRAFT,HS=++++++\0D
S:PLOT CONTACTS,CM
PLOT,HS=++\0D
--ALL OF THEM,HS=\0D
--SUBMARINE-,HS=+\0D
--SURFACE-,HS=++\0D
--AIRCRAFT-,HS=+++\0D
-GROUP ID,HS=++++\0D
S:PLOT CLASS,CM,NS=CONTACT_TYPE,CT=2
-CLASS,HS=+++++\0D
---SUBMARINE-,HS=\0D
---SURFACE-,HS=+\0D
```

```
---AIRCRAFT-,HS=++\0D
S:SPECIAL CONTACT,CM
SPECIAL,HS=++++++\0D
STATUS,HS=\0D
HISTORY,HS=+\0D
BEST FIT TRACK,HS=++\0D
DEAD RECKONING,HS=+++\0D
RADIAL EXPANSION,HS=++++\0D
----SUBMARINE,HS=\0D
----SURFACE,HS=+\0D
----AIRCRAFT,HS=++\0D
ERASE LAST,HS=+++++\0D
S:BUILD ELLIPSE,CM,NS=COMMON,CT=1
BUILD,HS=+++\0D
LAT LONG,HS=\0D
HUFF DUFF,HS=+\0D
ENTER ELLIPSE,HS=++\0D
-EDIT,HS=+++\0D
-DELETE ALL,HS=++++\0D
<CR>
```

This completes the programming of the file. The V> prompt should be displayed. Save the file by typing:

FSV A CONTACTS <CR>

You will see:

Saving Data...Save Complete

B. TRAINING THE VOCABULARY

To begin training, at the V> prompt type:

TRS<CR>

You will see:

Single word training (<CR>,X)

Press <CR>. You will hear the beep and see:

001 GO_TO_SLEEP

Say "GO_TO_SLEEP" You will then see:

Proceed? (y,n,x,g) or any number of error messages. If you are not sure of yourself or you get an error message, do not proceed, type "n" and try again. If you get an error message you will find its meanings in the users guide. The VOTAN will proceed through your vocabulary to the end. You must have two templates for each word before you can train in phrases, if you elect to do that. (See chapter III) You can now exercise your vocabulary. To exercise the vocabulary means to practice saying the words for recognition. The VOTAN is in the Off Line mode with no commands going to the host. At the V> prompt type EXR<CR>. You will see:

Continuous Recognition

You may now say any of the words that you have trained. The voice card will have only the "COMMON" set active at this time. You must first say one of the words in the "COMMON" set, to switch to another set, say the name of the set label. As you say the words, they will appear on the screen. The set label will appear twice, once to identify it as a set label and the second time with its associated word number. Figure B.1 is an example of the displays when exercising the vocabulary.

```
NUMBERS
  005 NUMBER     dist1=024     039 NEW_CONTACT     dist2=071
  006 ONE        dist1=026     016 NORTH           dist2=048
  011 SIX        dist1=023     020 ESCAPE          dist2=033
DATA
  037 EDIT       dist1=006     038 EXIT            dist2=030
```

Figure B.1 Vocabulary Exercise Display

After you are satisfied with your vocabulary exercise, get back to the V> prompt by holding down the "Ctrl" key and pressing the V key. The dist1 and dist2 are assigned values to the level of recognition, 0 being the best and 255 the worst (see chapter III). Dist1 is assigned to the recognized word and dist2 the next closest word. The Acceptance Level is set at 50, if a word does not have a distance less than or equal to 50, it will not be recognized. Note that many times both dist1 and dist2 are less than 50, the lowest distance will be recognized. If your dist1 is consistently low, you may want to lower the Acceptance Level. In the above example a 30 would do.

C. INTERFACING WITH ITDA

After the vocabulary is programmed and trained, it is time to apply it to the ITDA. Put the VOTAN on line by typing ONL<CR>. Turn on the ITDA Hard Disk and the HP 9020. Log on as a "Super User". At the login prompt type "root". At the

prompt for password enter the password. At the # prompt type: init 2. You have now activated the second port of the MUX card, this is where the RS 232 cable should be. Press "Ctrl and D", this will log you off of the HP 9020. Now go to the VT 100 terminal. You should have a login prompt, login to your account. At the $ prompt type:

cat|/itdabin/itda <CR>

The HP 9020 screen will have some extraneous writing and graphics blocks over the menu items. Hold down the shift key and press key number 28 on the special function key pad of the HP 9020 to clear the blocks. Use the arrow keys to move the cursor to the top left hand corner of the screen and press the delete key until all writing has been removed. On the VT 100 terminal take the VOTAN off line with the Ctrl-ba sequence. Restore the file with: FRS A CONTACTS, put the VOTAN back on line with: ONL and begin operations.

APPENDIX C
CONTACTS MODULE MENU ITEMS WITH CORRESPONDING VOICE COMMANDS

The following is the "CONTACTS" module "CDA Tree Outline" for the ITDA version 2.0, which is currently in use at the Naval Postgraduate School. Some of the menu items differ from that published by NADC. The numbers correspond to the key which executes the command indicated. The words to the right are the recommended voice commands with output strings. VOTAN does not accept breaks between words, where two words are listed as either a set label or a vocabulary phrase, the words must be entered in VOTAN with an underscore, "_", between the words, such as "DELETE_ALL". Where a "+" symbol is shown, insert a space during the VOTAN programming.

By following this example one should be able to learn the tools used to create the vocabulary for the ITDA. It is more important to learn the tools so that individual users can create their own vocabulary than to be given a complete vocabulary for the following reasons: To be most comfortable with the voice input the user should tailor his vocabulary to best suit his needs and style. There are differences between individual versions of the ITDA which are in use, those differences significantly affecting the assigned values of the Host Strings (HS) for the vocabulary. The most significant reason is that until a change is made to the ITDA program which will provide remote users with required prompts, the use of voice is not very practicable. The required change is relatively minor and should be pursued.

This file will be labeled "CONTACTS". It will contain several sets. The vocabulary is listed with comments where appropriate. The comments are in brackets {}.

```
     {THE FILE IS NAMED "CONTACTS", RESTORE IT TO THE VOTAN
     WITH THE "FRS A CONTACTS" COMMAND}
     {THE FIRST SET IS LABELED "MAIN MENU", THERE IS ONLY ONE
     MEMBER OF THE SET, THAT BEING THE WORD FOR THE MODULE
     THAT IS WANTED; CONTACTS.}

                              S:MAIN_MENU,CM,NS=COMMON,CT=1

1 CONTACTS                    CONTACTS-,HS=\0D

     {THE FIRST LEVEL OF THE MENU HAS BEEN ENTERED INTO, THE
     USER NOW HAS THE SECOND LEVEL CHOICES DISPLAYED. FROM
     THIS POINT THE USER SELECTS THE TYPE OF ACTIVITY HE
     DESIRES BY SAYING THE NAME OF THE SET LABEL FOR THAT
     ACTIVITY.}

     {FOR AN EXISTING CONTACT}

11 INPUT CONTACT              S:EXISTING_CONTACT,CM,NS=COMMON,CT=1

     {AFTER ONE RECOGNITION FROM THIS SET,(CT=1) THE NEXT SET
     IS AUTOMATICALLY LOADED, THE NEXT SET BEING "COMMON",
     (NS=COMMON). THIS SET LABEL IS ALSO PART OF THE "COMMON"
     SET (CM).}

111 SUBSURF                   EXISTING_SUBMARINE,HS=1\0D

112 SURFACE                   EXISTING_SURFACE,HS=1+\0D

113 AIR                       EXISTING_AIRCRAFT,HS=1++\0D

     {AT THIS POINT VOTAN HAS SWITCHED TO THE COMMON SET,
     ITDA WILL PROMPT YOU TO ENTER A NAME OR NUMBER OF THE
     DISPLAYED CONTACTS, YOU CAN HAVE A SET CALLED "NAMES"
     AND KEEP IT UPDATED AND/OR USE THE "NUMBERS" SET, BOTH
     SETS SHOULD BE IN THE "COMMON" SET AND CAN BE RECALLED
     BY STATING THE NAME OF THE SET. YOU WILL SAY "NUMBERS"
     AND THEN SAY THE APPROPRIATE NUMBERS TO RESPOND TO THE
     PROMPT.}

                              S:REPORT_TYPE,CM,NS=DATA,CT=1

     {AFTER ENTERING THE NAME OR NUMBER OF THE CONTACT YOU
     WILL BE ASKED FOR THE REPORT TYPE, HENCE THE SET
     "REPORT TYPE". IT IS COMMON (CM), THEREFORE YOU MUST SAY
     "REPORT TYPE" TO HAVE THIS SET LOADED, THEN YOU MAY
     BEGIN SAYING WORDS FROM THIS SET. THE NEXT SET IS "DATA"
     WHICH WILL BE LOADED AFTER ONE RECOGNITION (CT=1).}

11#1 POSIT                    POSITION,HS=\0D

11#2 DATUM CIRCLE             DATUM_CIRCLE,HS=+\0D

11#3 LINE OF BRG              LINE_OF_BEARING,HS=++\0D

11#4 RANGE/BEARING            RANGE,HS=+++\0D

11#5 CZ CONTACT               CONTROL_ZONE,HS=++++\0D

11#6 ELLIPSE                  ELLIPSE,HS=+++++\0D

11#7 SOSUS BRG BOX            SOSUS_BOX,HS=++++++\0D

11#8 EXIT                     -EXIT,HS=+++++++\0D

     {THIS EXIT TAKES THE USER BACK TO THE "REPORT TYPE"
     PROMPT. "REPORT TYPE IS A COMMON SET, THE USER JUST SAYS
     "REPORT TYPE" AND VOTAN IS WHERE IT SHOULD BE.}
     {NOTE THIS "EXIT", ITS HOST STRING (HS) IS SEVEN SPACES
     FOLLOWED BY A CARRIAGE RETURN. THE NEXT "EXIT" HAS A
```

```
     DIFFERENT HOST STRING. VOTAN WILL NOT ALLOW THE SAME
     WORD TO HAVE MORE THAN ONE HOST STRING, EVEN THOUGH THEY
     ARE IN DIFFERENT SETS. TO GET AROUND THIS, USE DIFFERENT
     VARIATIONS IN THE SPELLING OF THE WORD OR ADD EXTRANEOUS
     CHARACTERS, SUCH AS THE - BEFORE THE E. SAY THE WORD THE
     SAME WAY EACH TIME YOU TRAIN. SINCE ONLY ONE SET IS
     ACTIVE AT A TIME, THERE WON'T BE A PROBLEM OF
     RECOGNITION, AND THE CORRECT HOST STRING WILL BE SENT.}

                              S:DATA,NS=COMMON,CT=1

     {THIS IS SET "DATA", IT IS NOT A COMMON SET AND THE WORD
     "DATA" WILL NOT BE PART OF THE VOCABULARY. THE ONLY WAY
     TO ACCESS THIS SET IS TO HAVE A RECOGNITION FROM THE
     "REPORT TYPE" SET. AFTER ONE RECOGNITION YOU WILL AGAIN
     HAVE THE COMMON SET LOADED.}

11##1 ACCEPT DATA             ACCEPT,HS=\0D

11##2 EDIT DATA               EDIT,HS=+\0D

11##3 DELETE DATA             DELETE,HS=++\0D

11##8 EXIT                    EXIT,HS=+++\0D

     {NOTE THIS "EXIT" HAS NO - BEFORE THE E. THIS EXIT ALSO
     TAKES THE USER BACK TO THE "REPORT TYPE" PROMPT.
     "REPORT TYPE IS A COMMON SET, THE USER JUST SAYS
     "REPORT-TYPE" AND VOTAN ADJUSTS THE VOICE CARD TO BE IS
     WHERE IT SHOULD BE.}

NEW CONTACT                   S:NEW_CONTACT,CM,NS=COMMON,CT=1

111                           NEW_SUBMARINE,HS=1\0D

112                           NEW_SURFACE,HS=1+\0D

113                           NEW_AIRCRAFT,HS=1++\0D

     {AT THIS POINT VOTAN HAS SWITCHED TO THE COMMON SET,
     ITDA WILL PROMPT YOU TO ENTER A NAME OR NUMBER OF THE
     CONTACT, SINCE IT IS A NEW CONTACT ENTER A NAME. YOU CAN
     HAVE A SET CALLED "NAMES" AND KEEP IT UPDATED AND/OR USE
     THE "ALPHABET" SET, BOTH SETS SHOULD BE IN THE "COMMON"
     SET AND CAN BE RECALLED BY STATING THE NAME OF THE SET.
     YOU WILL SAY "ALPHABET" AND THEN SPELL THE APPROPRIATE
     WORDS TO RESPOND TO THE PROMPT.}

                              S:CONTACT_TYPE,CM,NS=COMMON,CT=1

11#1 FRIENDLY                 FRIENDLY,HS=\0D

11#2 HOSTILE                  HOSTILE,HS=+\0D

11#3 NEUTRAL                  NEUTRAL,HS=++\0D

11#4 BATTLE GROUP             BATTLE_GROUP,HS=+++\0D

11#5 EXER HOSTILE             EXERCISE_ENEMY,HS=++++\0D

11#6 UNKNOWN                  UNKNOWN,HS=+++++\0D

11#8 EXIT                     EXIT-,HS=++++++\0D TOP OF MENU

     {THE FOLLOWING MENU ITEMS ARE ALREADY PROGRAMED IN
     PREVIOUS SETS AS INDICATED BY * SET LABEL}

11##1 POSIT                   * REPORT TYPE

11##2 DATUM CIRCLE            * REPORT TYPE
```

```
11##3 LINE OF BRG          * REPORT TYPE
11##4 RANGE/BEARING        * REPORT TYPE
11##5 CZ CONTACT           * REPORT TYPE
11##6 ELLIPSE              * REPORT TYPE
11##7 SOSUS BRG BOX        * REPORT TYPE
11##8 EXIT                 * REPORT TYPE
                           S:SPECIAL-FUNCTIONS,CM
118 EXIT                   TOP_OF_MENU,HS=\1BS

     {THIS FINISHES THE "INPUT CONTACT" PORTION OF THE
     "CONTACTS" MODULE. NOW IS THE TIME TO POINT OUT ONE OF
     THE PROBLEMS WITH THE ABOVE METHOD. NOTE THE ABOVE
     "EXIT-", WHEN THE USER CHOOSES THIS HE WILL BE TAKEN TO
     THE TOP OF THE MENU. THE VOTAN HOWEVER HAS SWITCHED TO
     THE SET "REPORT TYPE", IT WILL BE NECESSARY FOR THE USER
     TO SAY "INITIALIZE" TO GET VOTAN BACK WHERE IT SHOULD
     BE.}

12 MODIFY CONTACT
121 HARDCP OPTION          S:LATEST_HARD_COPY,CM,
                           NS=CONTACT_TYPE,CT=2
1211 LATEST CONTACT        LATEST_CONTACT,HS=21\0D
12111 ALL                  ALL_OF_THEM,HS=\0D
12112 SUBSURF              SUBMARINES,HS=+\0D
12113 SURFACE              SURFACE,HS=++\0D
12114 AIR                  AIRCRAFT,HS=+++\0D

     {THE SET LABEL "CONTACT TYPE", WILL BE SWITCHED TO
     AUTOMATICALLY AFTER TWO RECOGNITIONS FROM THIS SET}

1211#1 FRIENDLY            * CONTACT TYPE
1211#2 HOSTILE             * CONTACT TYPE
1211#3 NEUTRAL             * CONTACT TYPE
1211#4 BATTLE GROUP        * CONTACT TYPE
1211#5 EXER HOSTILE        * CONTACT TYPE
1211#6 UNKNOWN             * CONTACT TYPE
                           S:HARD_COPY_CONTACTS,CM
1212 ALL SUB               ALL_SUBMARINES,HS=21+\0D
1213 SPEC SUB              SPECIAL_SUBMARINE,HS=21++\0D
1214 ALL SURFACE           ALL_SURFACE,HS=21+++\0D
1215 SPEC SURFACE          SPECIAL_SURFACE,HS=21++++\0D
1216 ALL AIR               ALL_AIRCRAFT,HS=21+++++\0D
1217 SPEC AIR              SPECIAL_AIRCRAFT,HS=21++++++\0D
```

```
                                S:DELETE_OPTION,CM
122 DELETE OPTION               DELETE,HS=2+\0D
1221 ALL                        -ALL_OF_THEM,HS=\0D
                                S:ALL_OPTIONS,CM
1222 ALL SUB                    -SUBMARINE,HS=+\0D
1224 ALL SURFACE                -SURFACE,HS=+++\0D
1226 ALL AIR                    -AIRCRAFT,HS=++++++\0D
122#1 DELETE ALL                -DELETE-ALL,HS=\0D
122#2 DELETE ALL
      BEFORE TI                 ALL_BEFORE,HS=+\0D
                                S:SPECIAL_OPTIONS,CM
1223 SPEC SUB                   SPECIAL_SUBMARINE,HS=++\0D
1225 SPEC SURFACE               SPECIAL_SURFACE,HS=++++\0D
1227 SPEC AIR                   SPECIAL_AIRCRAFT,HS=++++++\0D
122#1 DELETE REPORT             DELETE_REPORT,HS=\0D
122#2 DELETE ALL
      BEFORE TI                 -ALL_BEFORE,HS=+\0D
122#3 DELETE ALL                --DELETE_ALL,HS=++\0D
                                S:EDIT_OPTION,CM
123 EDIT OPTION                 EDIT,HS=2++\0D
1231 SUBSURF                    --SUBMARINE,HS=\0D
1232 SURFACE                    --SURFACE,HS=+\0D
1233 AIR                        --AIRCRAFT,HS=++\0D
123#1 EDIT LINE                 EDIT_LINE,HS=\0D
123#2 EDIT NAME                 EDIT_NAME,HS=+\0D
123#3 EDIT TYPE                 EDIT_TYPE,HS=++\0D
123#31 SUBSURF                  * EDIT OPTION
123#32 SURFACE                  * EDIT OPTION
123#33 AIR                      * EDIT OPTION
123#3#1 FRIENDLY                * CONTACT TYPE
123#3#2 HOSTILE                 * CONTACT TYPE
123#3#3 NEUTRAL                 * CONTACT TYPE
123#3#4 BATTLE GROUP            * CONTACT TYPE
123#3#5 EXER HOSTILE            * CONTACT TYPE
123#3#6 UNKNOWN                 * CONTACT TYPE
123#4 EDIT ID CODE              EDIT_ID_CODE,HS=+++\0D
```

```
123#6 LIST CONTACT      LIST_CONTACTS,HS=++++\0D
                        S:PURGE_OPTION,CM
124 PURGE OPTION        PURGE,HS=2+++\0D
1241 ALL                -ALL_OF_THEM,HS=\0D
1242 ALL SUB            -ALL_SUBMARINE,HS=+\0D
1243 SPEC SUB           -SPECIAL_SUBMARINE,HS=++\0D
1244 ALL SURFACE        -ALL_SURFACE,HS=+++\0D
1245 SPEC SURFACE       -SPECIAL_SURFACE,HS=++++\0D
1246 ALL AIR            -ALL_AIRCRAFT,HS=+++++\0D
1247 SPEC AIR           -SPECIAL_AIRCRAFT,HS=++++++\0D
                        S:PLOT_CONTACTS,CM
13 PLOT CONTACT         PLOT,HS=++\0D
131 PLOT ALL            --ALL_OF_THEM,HS=\0D
132 PLOT SUBSURF        --SUBMARINE-,HS=+\0D
133 PLOT SURFACE        --SURFACE-,HS=++\0D
134 PLOT AIR            --AIRCRAFT-,HS=+++\0D
135 PLOT GROUP ID       -GROUP_ID,HS=++++\0D
                        S:PLOT_CLASS,CM,NS=CONTACT_TYPE,CT=2
136 PLOT CLASS          -CLASS,HS=+++++\0D
1361 SUBSURF            ---SUBMARINE-,HS=\0D
1362 SURFACE            ---SURFACE-,HS=+\0D
1363 AIR                ---AIRCRAFT-,HS=++\0D
136#1 FRIENDLY          * CONTACT TYPE
136#2 HOSTILE           * CONTACT TYPE
136#3 NEUTRAL           * CONTACT TYPE
136#4 BATTLE GROUP      * CONTACT TYPE
136#5 EXER HOSTILE      * CONTACT TYPE
136#6 UNKNOWN           * CONTACT TYPE
                        S:SPECIAL_CONTACT,CM
137 SPEC CONTACT        SPECIAL,HS=++++++\0D
1371 PLOT STATUS        STATUS,HS=\0D
1372 PLOT HISTORY       HISTORY,HS=+\0D
1374 BEST FIT TRACK     BEST_FIT_TRACK,HS=++\0D
1375 DEAD RECKONING     DEAD_RECKONING,HS=+++\0D
1376 RADIAL EXPANSION   RADIAL_EXPANSION,HS=++++\0D
```

```
137#1 SUBSURF              ----SUBMARINE,HS=\0D
137#2 SURFACE              ----SURFACE,HS=+\0D
137#3 AIR                  ----AIRCRAFT,HS=++\0D
1377 ERASE LAST SOLN       ERASE_LAST,HS=+++++\0D
                           S:BUILD_ELLIPSE,CM,NS=COMMON,CT=1
16 BUILD ELLIPSE           BUILD,HS=+++\0D
161 LAT/LNG BEARING        LAT_LONG,HS=\0D
163 HFDF BEARING           HUFF_DUFF,HS=+\0D
164 ENTER ELLIPSE          ENTER_ELLIPSE,HS=++\0D
165 EDIT CONTACTS          -EDIT,HS=+++\0D
166 DELETE ALL
    CONTACTS               -DELETE_ALL,HS=++++\0D
```

SUMMARY OF VOCABULARY BUILDING TOOLS

1. NAME THE FILE AFTER THE MAIN MENU ITEM. IE CONTACTS.

2. MAKE A NEW SET FOR EACH LEVEL. NAME THE SET SOMETHING THAT CORRESPONDS TO THE TYPE OF INFORMATION IN THAT SET, IE REPORT_TYPE, OR BY THE TYPE FUNCTION THAT IS PERFORMED, IE NEW_CONTACT. DO NOT NAME THE SET ONE OF THE FUNCTIONS THAT MUST BE PERFORMED.

3. FOR THE MOST PART, THE NEXT SET CAN AND SHOULD BE SPECIFIED. THIS MAKES THE SWITCH AUTOMATIC, AND REDUCES THE CHANCE FOR ERROR BY LIMITING THE AVAILABLE WORDS TO BE RECOGNIZED.

4. ALL SETS CAN BE LISTED AS "COMMON", HOWEVER ALL COMMON WORDS ARE ACTIVE AT ALL TIMES AND TAKE UP PART OF THAT VALUABLE 32K.

5. NON-COMMON SETS ARE THOSE THAT ONLY APPLY TO ONE SPECIFIC SET PREVIOUSLY USED, OR THAT ARE ONLY ACCESSED THOUGH ANOTHER SET. IE "DATA".

6. SAME WORDS WITH MULTIPLE MEANINGS CAN NOT BE IN THE SAME SET. THEY MUST HAVE A SPELLING VARIATION IN EACH OF THE DIFFERENT SETS THAT THEY ARE USED. IE: _EXIT, EXIT, EXIT_.

APPENDIX D
COMPLETE LISTING OF MENU ITEMS FOR THE CONTACTS MODULE WITH CORRESPONDING NUMBERS

The following is the CONTACTS module "CDA Tree Outline" for the ITDA version 2.0, revised 15 December 1986. The numbers correspond to the key which executes the command indicated. Due to the classification of this thesis an explanation of the various menu items is not provided. Where the "#" appears in the number sequence, the "#" may be substituted by any of the last digits from the group immediately preceding the group with the "#". Comments have been added to assist the reader in following the flow of commands. This menu outline is for the version of the ITDA currently in use at the Naval Postgraduate School and differs in some items from that published by NADC.

MAIN MENU

**********BEGINNING OF "CONTACTS" MODULE**********

1 CONTACTS

11 INPUT CONTACT

EXISTING CONTACT

111 SUBSURF

112 SURFACE

113 AIR

{HERE YOU ARE PROMPTED FOR THE NAME OR NUMBER OF THE CONTACT, A LIST IS PROVIDED FOR YOU}

* 11#1 POSIT

11#2 DATUM CIRCLE

11#3 LINE OF BRG

11#4 RANGE/BEARING

11#5 CZ CONTACT

```
          11#6 ELLIPSE
          11#7 SOSUS BRG BOX
               11##1 ACCEPT DATA
               11##2 EDIT DATA
               11##3 DELETE DATA
               11##8 EXIT     * {THIS EXIT TAKES YOU BACK
                                  TO THE PREVIOUS *}
          11#8 EXIT
     118 EXIT
          NEW CONTACT
     111 SUBSURF
     112 SURFACE
     113 AIR
          {HERE YOU ARE PROMPTED FOR A NAME FOR THE NEW
          CONTACT}
     **   11#1 FRIENDLY
          11#2 HOSTILE
          11#3 NEUTRAL
          11#4 BATTLE GROUP
          11#5 EXER HOSTILE
          11#6 UNKNOWN
          11#8 EXIT
               11##1 POSIT
               11##2 DATUM CIRCLE
               11##3 LINE OF BRG
               11##4 RANGE/BEARING
               11##5 CZ CONTACT
               11##6 ELLIPSE
               11##7 SOSUS BRG BOX
               11##8 EXIT     **
     118 EXIT
12 MODIFY CONTACT
     121 HARDCP OPTION
          1211 LATEST CONTACT
               12111 ALL
               12112 SUBSURF
```

12113 SURFACE

12114 AIR

1211#1 FRIENDLY

1211#2 HOSTILE

1211#3 NEUTRAL

1211#4 BATTLE GROUP

1211#5 EXER HOSTILE

1211#6 UNKNOWN

1212 ALL SUB

1213 SPEC SUB

1214 ALL SURFACE

1215 SPEC SURFACE

1216 ALL AIR

1217 SPEC AIR

122 DELETE OPTION

1221 ALL

1222 ALL SUB

122#1 DELETE ALL

122#2 DELETE ALL BEFORE TI

1223 SPEC SUB

12231 DELETE REPORT

12232 DELETE ALL BEFORE TI

12233 DELETE ALL

1224 ALL SURFACE

12241 DELETE ALL

12242 DELETE ALL BEFORE TI

1225 SPEC SURFACE

12251 DELETE REPORT

12252 DELETE ALL BEFORE TI

12253 DELETE ALL

1226 ALL AIR

12261 DELETE ALL

12262 DELETE ALL BEFORE TI

1227 SPEC AIR

12271 DELETE REPORT

12272 DELETE ALL BEFORE TI
12273 DELETE ALL
123 EDIT OPTION
1231 SUBSURF
1232 SURFACE
1233 AIR
123#1 EDIT LINE
123#2 EDIT NAME
123#3 EDIT TYPE
123#31 SUBSURF
123#32 SURFACE
123#33 AIR
123#3#1 FRIENDLY
123#3#2 HOSTILE
123#3#3 NEUTRAL
123#3#4 BATTLE GROUP
123#3#5 EXER HOSTILE
123#3#6 UNKNOWN
123#4 EDIT ID CODE
123#6 LIST CONTACT
124 PURGE OPTION
1241 ALL
1242 ALL SUB
1243 SPEC SUB
1244 ALL SURFACE
1245 SPEC SURFACE
1246 ALL AIR
1247 SPEC AIR
13 PLOT CONTACT
131 PLOT ALL
132 PLOT SUBSURF
133 PLOT SURFACE
134 PLOT AIR
135 PLOT GROUP ID
136 PLOT CLASS

1361 SUBSURF

1362 SURFACE

1363 AIR

136#1 FRIENDLY

136#2 HOSTILE

136#3 NEUTRAL

136#4 BATTLE GROUP

136#5 EXER HOSTILE

136#6 UNKNOWN

137 SPEC CONTACT

1371 PLOT STATUS

1372 PLOT HISTORY

1374 BEST FIT TRACK

1375 DEAD RECKONING

1376 RADIAL EXPANSION

137#1 SUBSURF

137#2 SURFACE

137#3 AIR

1377 ERASE LAST SOLN

16 BUILD ELLIPSE

161 LAT/LNG BEARING

163 HFDF BEARING

164 ENTER ELLIPSE

165 EDIT CONTACTS

166 DELETE ALL CONTACTS

APPENDIX E
SCENARIO APPLICATIONS

The hypothetical situation and mission is as follows: The US Naval Forces have been given the mission of escorting Oil Tankers through the Gulf of Oman, the Straits of Hormuz, and into the Arabian Sea.

DESIRED INFORMATION: Satellite coverage for H-hour. The locations and dispositions of all friendly vessels, all enemy vessels, and all commercial vessels. Present the above information in hard copy form.

KNOWN INFORMATION: H-hour, D-day, Latitude and Longitude of the center of the Straits of Hormuz, group name of the friendly units.

ITDA DATA BASE INFORMATION: Current location of all known vessels, Satellite Tracks.

VOCABULARY

```
S:MIDDLE EAST,CM
H HOUR,HS=311550JUL87\0D
EASTERN,HS=\1BP\0D2630N05630E
WORLD,HS=\0D7000\0D
SATELLITE,HS=82417    \0D
STRAITS OF HORMUZ,HS=\1BP\0D
ARABIAN SEA,HS=\0D0400\0D
SEARCH,HS=2\0DN\0D
DISPOSITION,HS=\1BS\0D
ENEMY SUBMARINES,HS=361 \0D
ENEMY SURFACE,HS=62 \0D
ENEMY AIRCRAFT,HS=63 \0D
FRIENDLY FORCES,HS=    \0D
BLUE FORCE,HS=BLUE FORCE\0D
HARD COPY,HS=\1BW\0D548\0D
AREA,HS=       \0D
DRIVE ON,HS=Y\0DY\0DY\0DY\0D
CEASE WORK,HS=N\0D
15 MINUTES,HS=\0D  \0D15\0D
COMMERCIAL,HS=62  \0D
```

EXECUTION

VERBAL COMMAND	ACTION ON THE ITDA
EASTERN	BEGINS CHANGING THE MAP DISPLAY TO THE EASTERN HEMISPHERE.
WORLD	SETS THE RADIUS OF THE DISPLAY SCREEN, THESE TWO WORDS MUST BE USED TOGETHER.

{THE SCREEN WILL NOW BE ADJUSTING TO THE EASTERN HEMISPHERE}

SATELLITE	BEGINS THE SEQUENCE TO DISPLAY THE SATELLITE COVERAGE.
H_HOUR	GIVES THE DATE TIME GROUP FOR THE TRACK SEARCH.
15_MINUTES	SETS THE TRACK DURATION AT 15 MINUTES. THESE THREE WORDS MUST BE GIVEN TOGETHER.

{THE SCREEN NOW SHOWS THE SATELLITE TRACKS}

DRIVE_ON	EXTENDS THE SATELLITE TRACKS FOR ONE HOUR.
CEASE_WORK	ENDS THE SATELLITE TRACK PROGRAM.
HARD_COPY	ACTIVATES THE PRINTER FOR THE GEOPLOT.
STRAITS_OF_HORMUZ	BEGINS ZOOMING IN ON THE STRAITS OF HORMUZ.
ARABIAN_SEA	SETS THE RADIUS OF THE DISPLAY AT 400 MILES, THESE TWO MUST BE GIVEN TOGETHER.
AREA SEARCH	RESTART THE SATELLITE TRACK PROGRAM. ENDS THE SATELLITE TRACK PROGRAM. THESE TWO MUST BE GIVEN TOGETHER.
DISPOSITION	BEGINS SEQUENCE FOR PLOTTING VESSELS.
ENEMY_SUBMARINES	PLOTS ALL KNOWN ENEMY SUBMARINES.
ENEMY_SURFACE	PLOTS ALL KNOWN ENEMY SURFACE.
ENEMY_AIRCRAFT	PLOTS ALL KNOWN ENEMY AIR ASSETS.
COMMERCIAL	PLOTS ALL KNOWN COMMERCIAL VESSELS.
FRIENDLY_FORCES	BEGINS SEQUENCE TO PLOT A FRIENDLY GROUP.
BLUE_FORCE	PLOTS THE GROUP NAMED BLUE_FORCE.

{THE GEOPLOT NOW DISPLAYS ALL KNOWN ASSETS IN THE AREA, ENEMY, FRIENDLY, COMMERCIAL, SUBSURFACE, SURFACE, AND AIR.}

The operator was free to move about, he was able to take the print out of the geoplot from the printer and pass it on to the commander, he was also able to operate additional keyboards. The total number of voice commands is 19, the total number of manual commands to accomplish the same scenario is 96. A significant difference, voice is much faster and the opportunities for errors is much less.

APPENDIX F
COMPLETE MENU STRUCTURE FOR ITDA VERSION 2.0

The following is the "CDA Tree Outline" for the ITDA version 2.0, revised 15 December 1986. As published by NADC. The numbers correspond to the key which executes the command indicated. Due to the classification of this thesis an explanation of the various menu items is not provided. Where the "#" appears in the number sequence, the "#" may be substituted by any of the last digits from the group immediately preceding the group with the "#".

MAIN MENU

**********BEGINNING OF "CONTACTS" MODULE**********

1 CONTACTS

- 11 INPUT CONTACT
  - 111 SURFACE
  - 112 SUBSURF
  - 113 AIR

EXISTING CONTACT

* 11#1 POSIT
- 11#2 DATUM CIRCLE
- 11#3 LINE OF BRG
- 11#4 RANGE/BEARING
- 11#5 CZ CONTACT
- 11#6 ELLIPSE
- 11#7 SOSUS BRG BOX
  - 11##1 ACCEPT DATA
  - 11##2 EDIT DATA
  - 11##3 DELETE DATA
  - 11##8 EXIT *

NEW CONTACT

** 11#1 FRIENDLY
- 11#2 HOSTILE

11#3 NEUTRAL
11#4 BATTLE GROUP
11#5 EXER HOSTILE
11#6 UNKNOWN
11#8 EXIT
11##1 POSIT
11##2 DATUM CIRCLE
11##3 LINE OF BRG
11##4 RANGE/BEARING
11##5 CZ CONTACT
11##6 ELLIPSE
11##7 SOSUS BRG BOX
11##8 EXIT **

12 MODIFY CONTACT
121 HARDCP OPTION
1211 LATEST CONTACT
12111 ALL
12112 SUBSURF
12113 SURFACE
12114 AIR
1211#1 FRIENDLY
1211#2 HOSTILE
1211#3 NEUTRAL
1211#4 BATTLE GROUP
1211#5 EXER HOSTILE
1211#6 UNKNOWN
1212 ALL SUB
1213 SPEC SUB
1214 ALL SURFACE
1215 SPEC SURFACE
1216 ALL AIR
1217 SPEC AIR
122 DELETE OPTION
12[illegible] ALL
1[illegible] ALL SUB

122#1 DELETE ALL
122#2 DELETE ALL BEFORE TI
1223 SPEC SUB
12231 DELETE REPORT
12232 DELETE ALL BEFORE TI
12233 DELETE ALL
1224 ALL SURFACE
12241 DELETE ALL
12242 DELETE ALL BEFORE TI
1225 SPEC SURFACE
12251 DELETE REPORT
12252 DELETE ALL BEFORE TI
12253 DELETE ALL
1226 ALL AIR
12261 DELETE ALL
12262 DELETE ALL BEFORE TI
1227 SPEC AIR
12271 DELETE REPORT
12272 DELETE ALL BEFORE TI
12273 DELETE ALL
123 EDIT OPTION
1231 SUBSURF
1232 SURFACE
1233 AIR
123#1 EDIT LINE
123#2 EDIT NAME
123#3 EDIT TYPE
123#31 SUBSURF
123#32 SURFACE
123#33 AIR
123#3#1 FRIENDLY
123#3#2 HOSTILE
123#3#3 NEUTRAL
123#3#4 BATTLE GROUP
123#3#5 EXER HOSTILE

123#3#6 UNKNOWN

123#4 EDIT ID CODE

123#6 LIST CONTACT

124 PURGE OPTION

1241 ALL

1242 ALL SUB

1243 SPEC SUB

1244 ALL SURFACE

1245 SPEC SURFACE

1246 ALL AIR

1247 SPEC AIR

13 PLOT CONTACT

131 PLOT ALL

132 PLOT SUBSURF

133 PLOT SURFACE

134 PLOT AIR

135 PLOT GROUP ID

136 PLOT CLASS

1361 SUBSURF

1362 SURFACE

1363 AIR

136#1 FRIENDLY

136#2 HOSTILE

136#3 NEUTRAL

136#4 BATTLE GROUP

136#5 EXER HOSTILE

136#6 UNKNOWN

137 SPEC CONTACT

1371 PLOT STATUS

1372 PLOT HISTORY

1374 BEST FIT TRACK

1375 DEAD RECKONING

1376 RADIAL EXPANSION

137#1 SUBSURF

137#2 SURFACE

137#3 AIR

1377 ERASE LAST SOLN

16 BUILD ELLIPSE

161 LAT/LNG BEARING

163 HFDF BEARING

164 ENTER ELLIPSE

165 EDIT CONTACTS

166 DELETE ALL CONTACTS

**********BEGINNING OF "WARFARE" MODULE**********

2 WARFARE

21 ASW

211 LOC

2111 ASW COVERAGE

21111 TABLE TGT/FREQ

21112 FOM TABLE

2111#1 LIST

2111#2 INPUT

2111#3 EDIT

2111#4 DELETE

21113 PLAN SCREEN

211131 SELECT TARGET

211132 SELECT ASSET

2111321 CTC DATA

21113211 SUBSURF

21113212 SURFACE

21113213 AIR

2111322 USER SELECT

2111323 DELETE

211133 SCREEN CENTER

211134 SELECT STATION

211135 COMPUTE COVERAGE

2112 AREA SEARCH

21121 CURSOR AREA

211211 PLOT AREA1
211212 NEW AREA1
211213 PLOT AREA2
211214 NEW AREA2
211215 PLOT AREA3
211216 NEW AREA3
21122 AREA PD CALC
211221 AREA SIZE
211222 DELETE RANGE
211223 SEARCH SPEED
211224 TARGET SPEED
211225 SEARCH TIME
2113 SEARCH BARRIER
21131 GENERAL BARRIER
21132 CURSOR BARRIER
2113#1 BARRIER LENGTH
2113#2 DETECT RANGE
2113#3 BARRIER SPEED
2113#4 TARGET SPEED
2113#5 TARGET WINDOW
2113#6 ADV/REC ANGLE
2113#7 SECTOR COVRG
2114 ASW PLANNING
21141 SUBSURF
21142 SURFACE
21143 AIR
2114#1 SET TIME
2114#2 EXECUTE ON
2114#4 REPORT ACT/DEAC
2114#6 PLOT HISTORY
2115 BOUY PLANNING
21151 INPUT
21152 MODIFY
21153 DELETE
2116 PROPLOSS

21161 DESIG ENV
21162 EDIT ENV
21163 SSP
211631 BT
2116311 LIST BT
2116312 ADD BT
2116313 EDIT BT
2116314 DELETE BT
2116315 DELETE ALL
2116316 CONVERT TO SSP
211632 TXBT
21165 RUN RAYMODE
21167 LST/PLT PROPLOSS
211671 LIST PROPLOSS
211672 PLOT PROPLOSS
211673 SELECT FILE

212 ENGAGE
2121 AIM POINT
2122 SELECT YIELD
21221 DIAL A YIELD
21222 10KT
21223 20KT
21224 100KT
21225 1MEG
21226 CHANGE VARIABLE
2122#1 TOP VIEW
2122#11 REMOVE ALL
2122#12 TOGGLE PTV1
2122#13 TOGGLE PVT10
2122#14 TOGGLE BSURGE
2122#15 TOGGLE POOL
2122#16 TOGGLE ASHOCK
2122#17 TOGGLE PVV
2122#2 SIDE VIEW
2122#21 TOGGLE PVT1

2122#22 TOGGLE PVT10

2122#23 TOGGLE ASHOCK

2122#3 ESR/OSR

2122#31 TOGGLE ESR PVV

2122#32 TOGGLE OSR PVV

2122#33 TOGGLE VERBOSE

2122#4 BLUEOUT

2123 ASROC

21231 TOP VIEW

212311 REMOVE ALL

212312 TOGGLE PTV1

212313 TOGGLE PVT10

212314 TOGGLE BSURGE

212315 TOGGLE POOL

212316 TOGGLE ASHOCK

212317 TOGGLE PVV

21232 SIDE VIEW

212321 TOGGLE PVT1

212322 TOGGLE PVT10

212323 TOGGLE VERBOSE

21233 ESR/OSR

212331 TOGGLE ESR PVV

212332 TOGGLE OSR PVV

212333 TOGGLE VERBOSE

21234 BLUEOUT

2124 SUBROC

21241 SUBROC1

21242 SUBROC2

2124#1 TOP VIEW

2124#11 REMOVE ALL

2124#12 TOGGLE PTV1

2124#13 TOGGLE PVT10

2124#14 TOGGLE BSURGE

2124#15 TOGGLE POOL

2124#16 TOGGLE ASHOCK

2124#17 TOGGLE PVV

2124#2 SIDE VIEW

2124#21 TOGGLE PVT1

2124#22 TOGGLE PVT10

2124#23 TOGGLE ASHOCK

2124#3 ESR/OSR

2124#31 TOGGLE ESR PVV

2124#32 TOGGLE OSR PVV

2124#33 TOGGLE VERBOSE

2124#4 BLUEOUT

2125 B57/SEALANCE

21251 SEA LANCE1

21252 SEA LANCE2

21253 SEA LANCE3

21254 B57 1

21255 B57 2

21256 B57 3

2125#1 TOP VIEW

2125#11 REMOVE ALL

2125#12 TOGGLE PTV1

2125#13 TOGGLE PVT10

2125#14 TOGGLE BSURGE

2125#15 TOGGLE POOL

2125#16 TOGGLE ASHOCK

2125#17 TOGGLE PVV

2125#2 SIDE VIEW

2125#21 TOGGLE PVT1

2125#22 TOGGLE PVT10

2125#23 TOGGLE ASHOCK

2125#3 ESR/OSR

2125#31 TOGGLE ESR PVV

2125#32 TOGGLE OSR PVV

2125#33 TOGGLE VERBOSE

2125#4 BLUEOUT

22 AAW

221 UNIT PIM

2211 ADD/EDT UNIT

22111 LOCAL UNIT

221111 SUBSURF

221112 SURFACE

221113 AIR

22111#1 FRIENDLY

22111#2 HOSTILE

22111#3 NEUTRAL

22111#4 BATTLE GROUP

22111#5 EXER HOSTILE

22111#6 UNKNOWN

22111##1 LAT/LNG

22111##2 BRG/RNG

22111##3 CURSOR

22111##7 ACTION FUNCTION

22111##71 RANGE BRG

22111##711 UNIT LABEL

22111##712 CURSOR POINT

22111##713 LAT LNG

22111##72 CPA

22111##73 SELECTIVE ERASE

22111##74 SELECTIVE DRAW

22111##75 UPDATE TIME

22111##76 START TIME

22111##761 UNIT LABEL

22111##762 LAT/ LNG

22111##763 REFUNIT BRG/RNG

22111##764 CURSOR POINT

22112 GLOBAL AIR

22113 GLOBAL SURFACE

22114 GLOBAL SUB

22117 ACTION FUNCTION

221171 RANGE BRG

2211711 UNIT LABEL

2211712 CURSOR POINT

2211713 LAT/LNG

221172 CPA

221173 SELECTIVE ERASE

221174 SELECTIVE DRAW

221175 UPDATE TIME

221176 START TIME

2211761 UNIT LABEL

2211762 LAT/LNG

2211763 REFUNIT BRG/RNG

2211764 CURSOR POINT

2212 DELETE UNIT

2213 BUILD TRACK

22131 ADD/EDT TRACK

* 221311 ENTER LAT/LNG

221312 ENTER BRG/RNG

221313 ENTER CURSOR * (IF NEW TRACK)

22132 UNIT TRACK

221321 ADD LEG

** 221322 MODIFY LEG

22132#1 ENTER LAT/LNG

22132#2 ENTER BRG/RNG

22132#3 ENTER CURSOR ** (IF EXSISTING TRACK)

221323 DELETE LEG

22137 ACTION FUNCTION

221371 RANGE BRG

2213711 UNIT LABEL

2213712 CURSOR POINT

2213713 LAT/LNG

221372 CPA

221373 SELECTIVE ERASE

221374 SELECTIVE DRAW
221375 UPDATE TIME
221376 START TIME
2213761 UNIT LABEL
2213762 LAT/LNG
2213763 REFUNIT BRG/RNG
2213764 CURSOR POINT
2214 DELETE TRACK
2216 DELETE ALL
2217 ACTION FUNCTION
22171 RANGE BRG
221711 UNIT LABEL
221712 CURSOR POINT
221713 LAT/LNG
22172 CPA
22173 SELECTIVE ERASE
22174 SELECTIVE DRAW
22175 UPDATE TIME
22176 START TIME
221761 UNIT LABEL
221762 LAT/LNG
221763 REFUNIT BRG/RNG
221764 CURSOR POINT
222 GRAPHICS
2221 CIRCLE
2222 RECTANGLE
2223 ELLIPSE
222#1 RED
222#2 YELLOW
222#3 GREEN
222#4 CYAN
222#5 BLUE
222#6 MAGENTA
222#7 WHITE
222#8 ERASE

2224 SECTOR

22241 AXIS RADIALS

22242 RADIALS

22243 BOUND RADIALS

2224#1 RED

2224#2 YELLOW

2224#3 GREEN

2224#4 CYAN

2224#5 BLUE

2224#6 MAGENTA

2224#7 WHITE

2224#8 ERASE

2227 ACTION FUNCTION

22271 RANGE BRG

222711 UNIT LABEL

222712 CURSOR POINT

222713 LAT/LNG

22272 CPA

22273 SELECTIVE ERASE

22274 SELECTIVE DRAW

22275 UPDATE TIME

22276 START TIME

222761 UNIT LABEL

222762 LAT/LNG

222763 REFUNIT BRG/RNG

222764 CURSOR POINT

223 INTCPT

2231 INTCPT THREAT

2232 AEW STATION

22321 COMPUTE AEW RNG

22322 INPUT AEW RNG

22327 ACTION FUNCTION

223271 RANGE BRG

2232711 UNIT LABEL

2232712 CURSOR POINT

2232713 LAT/LNG

223272 CPA

223273 SELECTIVE ERASE

223274 SELECTIVE DRAW

223275 UPDATE TIME

223276 START TIME

2232761 UNIT LABEL

2232762 LAT/LNG

2232763 REFUNIT BRG/RNG

2232764 CURSOR POINT

2233 LNG RNG INTCPT

2237 ACTION FUNCTION

22371 RANGE BRG

223711 UNIT LABEL

223712 CURSOR POINT

223713 LAT/LNG

22372 CPA

22373 SELECTIVE ERASE

22374 SELECTIVE DRAW

22375 UPDATE TIME

22376 START TIME

223761 UNIT LABEL

223762 LAT/LNG

223763 REFUNIT BRG/RNG

223764 CURSOR POINT

224 TACTICS

2241 CAP STA

22411 FIXED CAP RANGE

22412 COMPUTE KEEP OUT

22413 COMPUTE CAP RANGE

2243 VECTOR LOGIC

22431 MODIFY GRID/STA

224311 V1 GRID PARAMS

224312 LIST STATIONS

224313 ADD STATION

224314 MODIFY STATION
224315 DELETE STATION
224317 ACTION FUNCTION
2243171 RANGE BRG
22431711 UNIT LABEL
22431712 CURSOR POINT
22431713 LAT/LNG
2243172 CPA
2243173 SELECTIVE ERASE
2243174 SELECTIVE DRAW
2243175 UPDATE TIME
2243176 START TIME
22431761 UNIT LABEL
22431762 LAT/LNG
22431763 REFUNIT BRG/RNG
22431764 CURSOR POINT
22432 OVERLAY GRID
22433 OVERLAY THREAT
22434 OVERLAY STATIONS
22435 TANKING
224351 GRID MILEAGE
2243511 # OF SECTORS
22435111 ONE
22435112 TWO
22435113 THREE
2243512 MR/LR DISTANCE
2243513 V1 DISTANCE
224352 GRID TIMING
2243521 TIME GOAL
2243522 FUEL TIME
2243523 1BK TOINTIME
224353 ADD PLATFORM
2243531 CAP
2243532 CBK
2243533 LBK

2243534 SHUTTLE
2243535 KINGPIN
2243536 SAC
2243537 DLI
224354 DEL PLATFORM
224355 MOD PLATFORM
224357 GRID MANAGER
2243571 STORE GRID
2243572 RECALL GRID
2243573 PURGE GRID
2243577 RUN GRID
22437 ACTION FUNCTION
224371 RANGE BRG
2243711 UNIT LABEL
2243712 CURSOR POINT
2243713 LAT/LNG
224372 CPA
224373 SELECTIVE ERASE
224374 SELECTIVE DRAW
224375 UPDATE TIME
224376 START TIME
2243761 UNIT LABEL
2243762 LAT/LNG
2243763 REFUNIT BRG/RNG
2243764 CURSOR POINT
2247 ACTION FUNCTION
22471 RANGE BRG
224711 UNIT LABEL
224712 CURSOR POINT
224713 LAT/LNG
22472 CPA
22473 SELECTIVE ERASE
22474 SELECTIVE DRAW
22475 UPDATE TIME
22476 START TIME

224761 UNIT LABEL
224762 LAT/LNG
224763 REFUNIT BRG/RNG
224764 CURSOR POINT

226 STORE RECALL
2261 STORE DATA
2262 RECALL DATA
2263 PURGE DATA

227 ACTION FUNCTION
2271 RANGE BRG
22711 UNIT LABEL
22712 CURSOR POINT
22713 LAT/LNG
2272 CPA
2273 SELECTIVE ERASE
2274 SELECTIVE DRAW
2275 UPDATE TIME
2276 START TIME
22761 UNIT LABEL
22762 LAT/LNG
22763 REFUNIT BRG/RNG
22764 CURSOR POINT

23 ASUW
231 LOC
2311 SURF SURVEIL
23111 CURRENT SSSC
231111 GEOPLOT OVERLAY
231112 REVIEW ASSIGNS
2311121 ENTER LAUNCH
2311122 EDIT CYCLE
2311123 DEBRIEF UPDATE
231113 HRDCPY ASSIGNS
23112 PLAN SSSC
231121 GEOPLOT ANLYS MAP
231122 REVIEW ASSIGNS

231123 HRDCOPY ASSIGNS
231124 PLAN CYCLE
231125 RECALL LAST PLAN
231126 STORE PLAN
23113 OVERLAY SSSC GRID
23114 CHANGE SSSC MAP
231141 INIT REALTIME
231142 INIT ANALYSIS
231143 REALTIME TO ANALYS
231144 ANLYS - REALTIME
231145 REALTIME GRID
231146 ANALYS GRID
232 ENGAGE
2321 SASHEM
23211 PLAN SCENARIO
232111 ENVIRONMENT
232112 HOSTILE SAG
2321121 EDIT AOU
2321122 INPUT HOSTILE
2321123 EDIT HOSTILE
2321124 DELETE HOSTILE
232113 SHOOTER HARPOON
2321131 INPUT SHOOTER
2321132 EDIT SHOOTER
232113#1 CURSOR KEYS
232113#2 MANUAL ENTRY
2321133 DELETE SHOOTER
2321135 INPUT HARPOON
2321136 EDIT HARPOON
2321137 DELETE HARPOON
23212 LIST SCENARIO
232121 LIST ENVIRON
232122 LIST HOSTILES
232123 LIST SHOOTERS
232124 LIST HARPOONS

232125 DISPLAY RESULTS

23213 REDRAW DISPLAY

23214 PACQ/PHIT

232141 CALC PACQ

232142 CALC PHIT

232143 ENG SUMMARY

23216 FILE MANAGMNT

23217 DELETE SCENARIO

24 EW

241 SAT VUL

2411 SATELL REVIEW

24111 INPUT SATELL

24112 EDIT SATELL

24113 DELETE SATELL

24114 SATELL ACT/DEAC

24115 LIST SATELL

24117 HRDCOPY

2412 SATVUL CALC

2413 LIST TABLE

2414 HRDCOPY TABLE

2415 TIME LINE

2417 SATELL PLOT

24171 EFOV PLOT

24172 STEP EFOV PLOT

24173 TRACK SAT PLOT

24174 CLOSEUP SAT HIT

24175 SET TIME

242 SATCAT

2421 SATCAT COVERAGE

2422 SATCAT STATION

242#1 CURSOR

242#2 MANUAL

243 IREPS

**********(ELECTROMAGNETIC FUNCTIONS MAIN MENU)**********

2431 METEOROLOGICAL

24311 VIEW RADIOSONDE DATA FILE

24312 RADIOSONDE INITIAL ANALYSIS

2432 ELECTROMAGNETIC PROPOGATION

24321 ATMOSPHERIC REFRACTIVITY PROFILE GENERATOR

243211 ENTER AN M-UNIT PROFILE

243212 SPECIFY A RADIOSONDE DATA SET

243213 GENERATE A HISTORICAL REFRACTIVITY DATA SET

24322 SELECT REFRACTIVITY PROFILE

24323 EDIT THE EM SYSTEM DATA FILES

243231 PLATFORM RADAR/COMMUNICATION DEVICES

2432311 ADD A NEW PLATFORM

2432312 CHANGE AN EXISTING PLATFORM

24323121 ADD A NEW ELECTROMAG.DEVICE

243231211 SPECIFIC HEIGHT-FINDER RADAR

243231212 NON HEIGHT-FINDER RADAR

243231213 GENERIC HEIGHT-FINDER RADAR

243231214 COMM.DEVICE

24323122 CHANGE AN EXISTING EM DEVICE

24323123 DELETE AN EXISTING EM DEVICE

2432313 DELETE AN EXISTING PLATFORM

243232 JAMMER DEVICES

2432321 ADD A NEW JAMMER

2432322 CHANGE AN EXISTING JAMMER

2432323 DELETE AN EXISTING JAMMER

243233 COVER SYSTEMS

2432331 ADD A NEW COVER

24323311 METRIC

24323312 ENGLISH

2432332 CHANGE AN EXISTING COVER

2432333 DELETE AN EXISTING COVER

243234 LOSS SYSTEMS

2432341 ADD A NEW LOSS

24323411 METRIC

24323412 ENGLISH

2432342 CHANGE AN EXISTING LOSS

2432343 DELETE AN EXISITNG LOSS

243235 JAMMER VICTIM SYSTEMS

2432351 ADD A NEW JAMMER/VICTIM SYSTEM

24323511 METRIC

24323512 ENGLISH

2432352 CHANGE AN EXISTING JAMMER/VICTIM SYSTEM

2432353 DELETE AN EXISTING JAMMER/VICTIM SYSTEM

24324 ELECTROMAGNETIC PROPOGATION CONDITIONS SUMMARY

243241 METRIC

243242 ENGLISH

24325 ELECTROMAGNETIC PATH LOSS VERSUS RANGE

24326 ELECTROMAGNETIC COVERAGE DIAGRAM

24327 ELECTRONIC COUNTER MEASURES (ECM) EFFECTIVENESS

24328 ELECTRONIC SUPPORT MEASURES (ESM) RANGE TABLES

243281 METRIC

243282 ENGLISH

24329 SURFACE SEARCH RADAR RANGE TABLES

243291 METRIC

243292 ENGLISH

243210 HISTORICAL PROPAGATION CONDITION SUMMARY

2433 ADVANCE PAPER

*******(END OF THE ELECTROMAGNETIC FUNCTIONS MAIN MENU)******

244 RADAR SHADOWING

2441 TERRAIN DISPLAY

24411 PLOT ELEVATION

244111 SINGLE CELLS

244112 ENTIRE REGION

244114 ELEV'N PLOT TYP

2441141 DEFAULT PLOT

2441142 LOGRTHM PLOT

2441143 MIN/MAX PLOT

2442 STATIC AIRCRAFT

2443 MOVING AIRCRAFT

244#1 CURSOR

244#2 MANUAL

244##1 CURSOR

244##2 MANUAL

244##3 RNG/BRG FROM SHIP

244###1 HRDCOPY

2444 AREA CALCULAT

2445 BLIND ZONES

244#1 RED

244#2 YELLOW

244#3 GREEN

244#4 CYAN

244#5 BLUE

244#6 MAGENTA

244#7 WHITE

244#8 ERASE

244#81 ZOOM

244#82 DOUBLE RADIUS

2446 RADAR COVERAGE

24461 MARK SITE

244611 CURSOR

244612 MANUAL

24461#1 RED

24461#2 YELLOW

24461#3 GREEN

24461#4 CYAN

24461#5 BLUE

24461#6 MAGENTA

24461#7 WHITE

24461#8 ERASE

24462 TRACK PLANNING

244621 ESTBLH TRACK

244622 ELEV'N PROFILE

24464 MSL PROFILE

24465 AGL PROFILE

2447 MAINT'N DATABASE

24471 LOAD DTED

244711 FROM FLOPPY

```
                    244712 FROM CART. TAPE
                24472 ERASE DTED
                    244721 ERASE SGL CELLS
                    244722 ERASE ALL CELLS
                24474 COPY SCREENS
                    '44741 FLOPPY TO LIBR'Y
                    244742 LIBR'Y TO FLOPPY
                    244743 STORE SCREEN
                    244744 RECALL SCREEN
                    244745 DELETE SCREEN
                24477 SHOW CATALOG
                    244771 ENTIRE
                    244772 ON HARD DISK

**********(BEGINNING OF GENERAL SUPPORT MAIN MENU)*********

3 GENERAL SUPPORT
    33 FEATURE BUILD
        331 CHANGE DATABASE
        332 ACT/DEA DATABASE
        333 INPUT FEATURE
            3331 CURSOR
            3332 MANUAL
                333#1 OFF
                333#2 ON
                    333##1 RED
                    333##2 YELLOW
                    333##3 GREEN
                    333##4 CYAN
                    333##5 BLUE
                    333##6 MAGENTA
                    333##7 WHITE
                    333##8 ERASE
        334 EDIT FEATURE
            3341 CURSOR
```

```
            3342 MANUAL
         335 ACT/DEA FEATURE
         336 FEATURE COLOR CHG
            3361 RED
            3362 YELLOW
            3363 GREEN
            3364 CYAN
            3365 BLUE
            3366 MAGENTA
            3367 WHITE
            3368 ERASE
         337 TO EDIT CIRCLES / TO EDIT AREAS
   35 MODIFY PORTS
         351 ADD A PORT/ANCH
         352 MODIFY PORT/ANCH
            35#1 RED
            35#2 YELLOW
            35#3 GREEN
            35#4 CYAN
            35#5 BLUE
            35#6 MAGENTA
            35#7 WHITE
            35#8 ERASE
         353 DELETE PORT/ANCH
         357 HDCOPY PORT/ANCH

************(BEGIN "STAND ALONES" MAIN MENU)*****************

5 STAND ALONES
   51 PANDA
   52 ASODA
   54 TEPEE
   55 COPS

**************(END "STAND ALONES" MAIN MENU)*****************
```

6 UNIX SHELL

7 ADE

- 71 ADE ON/OFF
- 72 PLOT
  - 721 SUBSURF
  - 722 SURFACE
  - 723 AIR
  - 724 ALL
    - 72#1 FRIEND
    - 72#2 HOSTILE
    - 72#3 UNKNOWN
    - 72#4 ALL
  - 725 START PLOT
- 75 MOVE TO ITDA
  - 751 SUBSURF
  - 752 SURFACE
  - 753 AIR
  - 754 ALL
    - 75#1 FRIEND
    - 75#2 HOSTILE
    - 75#3 UNKNOWN
    - 75#4 ALL
  - 755 SNAP SHOT
  - 756 MOVE TRACK
- 76 PURGE ADE DATA

8 EXIT

FROM THE MAIN MENU "EXIT" OPTION THE FOLLOWING PROGRAMS ARE PRESENTED

02 END PROGRAM
04 MACHINE CONFIGURE

05 AUTO RECONFIG

- 051 LOAD TEPEE
- 052 REMOVE TEPEE
- 053 OCEAN DATA
  - 0531 ADD OCEAN DATA
    - 05311 ADD ATLANTIC
    - 05312 ADD SOUTH ATL
    - 05313 ADD PACIFIC
    - 05314 ADD INDIAN
    - 05315 ADD MEDITERR
- 054 LOAD HI RES MAP
- 055 REMV HI RES MAP

06 BACK UP OPTIONS

- 061 ALL DATA
- 062 USER DATA
- 063 CONTACT DATA
- 064 TRACK DATA
- 065 4-W DATA
- 066 SECTOR DATA
- 067 INIT FLOPPY

07 RESTORE OPTIONS

- 071 ALL DATA
- 072 USER DATA
- 073 CONTACT DATA
- 074 TRACK DATA
- 075 4-W DATA
- 076 SECTOR DATA
- 077 INIT FLOPPY

**********SPECIAL FUNCTION KEY TREE**********

S1 MAP OPTIONS

- S11 EDIT CNTRAD
- S12 ZOOM
- S13 NEW MAP

S14 CLEAN MAP
S15 DOUBLE
S16 CENTER ON
S161 CURSOR
S162 CONTACT
S1622 SURFACE
S1623 AIR
S163 TRACK PIM
S17 MAP STATUS
S171 LAT/LNG LINES
S172 LAND MASSES
S173 RESOLUT'N

S2 PLOTS
S21 PLOT STATUS
S22 PLOT CONTACTS
S221 PLOT ALL
S222 PLOT SUBSURF
S223 PLOT SURFACE
S224 PLOT AIR
S225 PLOT GROUP ID
S226 PLOT CLASS
S2261 SUBSURF
S2262 SURFACE
S2263 AIR
S226#1 FRIENDLY
S226#2 HOSTILE
S226#3 NEUTRAL
S226#4 BATTLE GROUP
S226#5 EXER HOSTILE
S226#6 UNKNOWN
S227 SPEC CONTACT
S2271 BY PLOT STATUS
S2272 PLOT HISTORY
S2274 BEST FIT TRACK
S2275 DEAD RECKONING

S2276 RADIAL EXPANSION

S227#1 SUBSURF

S227#2 SURFACE

S227#3 AIR

S2277 ERASE LAST SOLN

S23 PLOT OVERLAYS

S231 GEOPLOT 4-WHISKY

S232 GEOPLOT SECTOR

S23#1 PLOT ON PIM

S23#2 PLOT ON LAT/LNG

S233 SOSUS STATION

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